ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

Volume 93 MARCH 1979 No. 1

THE ROYAL ENGINEERS JOURNAL MARCH 1979
VOL 93 No. 1

THE COUNCIL OF THE INSTITUTION OF ROYAL ENGINEERS

(Established 1875, Incorporated by Royal Charter, 1923)

Patron—HER MAJESTY THE QUEEN

President

Major-General J C Woollett, CBE, MC, MA, C Eng, FICE	1974

Vice-Presidents

Brigadier J R E Hamilton-Baillie, MC, MA, C Eng, MICE	1975
Major-General C P Campbell, CBE, MBIM	1977

Elected Members

Colonel B A E Maude, MBE, MA	1965
Colonel K W Dale, TD, ADC, FCIBS, F Inst F, M Cons E	1976
Lieut-Colonel D O Vaughan	1976
Brigadier J A Notley, MBE	1976
Lieut-Colonel R J N Kelly, RE	1977
Colonel A J Carter, RE(V), OBE, TD	1977
Captain R L Walker, RE	1977
Captain J M Wyatt, RE	1978
Colonel W C S Harrison, CBE, ERD, C Eng, FICE, MIHE	1978
Lieut-Colonel R M Hutton, MBE, BSc, C Eng, FICE, MIHE	1978
Brigadier D J N Genet, AMBIM	1979

Ex-Officio Members

Brigadier R W M Lister, ADC	D/E-In-C
Colonel K J Marchant	AAG RE
Brigadier C J Rougier, BA	Comdt RSME
Major-General F M Sexton, OBE	D Mil Survey
Colonel J B Wilks	Regtl Colonel
Brigadier R W Dowdall	Comd 11 Engr Gp
Brigadier R Wheatley, OBE, C Eng, FICE, FIHE	D Engr Svcs
Brigadier J W Bridge	DPCC

Corresponding Members

Brigadier J F McDonagh *Australian Military Forces*	1974
Lieut-Colonel H E Wedde, BE(Civ), RNZE *Royal New Zealand Engineers*	1978
Major-General R E Ashton, CD *Canadian Forces*	1975
Brigadier S R Bagga *Indian Engineers*	1978
Major A F S Baines, RE *BAOR*	1978
Brigadier-General Chen Kwee Fong, KMN, AMP, PJK *Malaysian Armed Forces*	1978

Secretary and Editor RE Journal

Colonel E E Peel, BSc, C Eng, FICE	1972

Bankers

Lloyds Bank, Ltd, Cox's and King's Branch, 6 Pall Mall, SW1

ISSN 0035-8878

THE ROYAL ENGINEERS JOURNAL

Published Quarterly by The Institution of Royal Engineers, Chatham, Kent ME4 4UG. Telephone Medway (0634) 42669

Printed by W & J Mackay Ltd, Lordswood, Chatham, Kent ME5 8TD

Volume 93 MARCH 1979 No. 1

Contents

Authors alone are responsible for the statements made and the opinions expressed in their papers 4,250

Where Do We Go From Here?

We have changed the colour of the cover, we have introduced the authors, we are using more photographs—these are the immediately obvious changes in this, the first issue of Volume 93 of the *RE Journal*.

Some time ago I *heard* a radio programme entitled "Where do we go from here?" Like many similar programmes it was a forum for a number of widely differing views. It was different in one respect in that the majority of the opposed views stemmed from the inability to agree on "Where are we?"

For some time now there has been discussion on a publication policy for the family of the Corps. It had been suggested that the *RE Journal*, its *Supplement* and *The Sapper* could be combined into two publications, a Monthly and a Quarterly, instead of three. In so far as publications are concerned the answer to the question, "Where *are* we?", is that it has been agreed that, for the present, the *RE Journal* and its *Supplement* will retain their independence and continue to provide the service that the Members pay for and the majority want.

Let us consider "Where *might* we go from here?" The time may well come when some publication amalgamation might be the answer. The course is endangered by many rocks, including those of "Inappropriate Indignation", "Tribal Voices", "Indifference" (*what again!*), and "Disproportion". Let me give some examples of these attitudes:

A little boy killed his sister by locking her in a trunk—"He is a naturally tidy child"

In a discussion on economic progress in the EEC—"What the Germans do or say is of no interest to me—who wants to follow the example of a nation on the losing side in two World Wars"

In a plea of mitigation—"My son would not have such a terrible criminal record if the police stopped arresting him"

In a radio interview in Leeds on the effect of metrication—"Metrication won't affect me because I'm moving to Bradford next week"

In a discussion on the effect of radio on home life—"Wireless was a device to be listened to and was a focus of attention, radio just produces noise"

To navigate between such rocks will require patience and tolerance.

Leaving this field of speculation let us examine "Where *are* we going?".

On publications the forward looking attitude we have adopted means that we move to better, more stimulating and provocative Journals. I am extremely grateful to those who have heeded my *cri-de-coeur* and have submitted material for publication. At the same time the increased news-worthiness of the Supplement will become more apparent. *The History of the Corps of Royal Engineers, Volume X, 1948–58*, is drafted and is being checked now, it will be published late 1979 or early 1980. Material for Volume XI is being collected.

The Museum is following several new paths. By a small re-arrangement of the layout our history will be shown chronologically. More emphasis is being placed on engineer equipment, tools and materials. Variety in the methods of presentation will add to the interest (this will include a display of the whole of our very fine medal collection). The capability of teaching aspects of engineering history is being developed; the Junior Leaders Regiment have already taken advantage of this as have local schools and clubs. A guidebook will shortly be on sale as well as other souvenirs.

In the Library two major projects are in hand to improve the retrieval of information; first, the re-classification of photographs and maps; and second, after the completion of the work in hand to strengthen the floor of the Annexe, the replanning of the storage system which will also overcome the overcrowding problem.

The changes in hand and planned answer the question "Where do we go from here?"—we go forward to provide a better service to the Corps as a whole as well as our Members.

A Prophetic Vision of New Techniques for the Corps

COLONEL A J HARRIS CBE, B Sc (Eng), FICE, FI Struct E, M'Cons E

Colonel Alan Harris, the Senior Partner of the Consultants, Harris and Sutherland, is also Professor of Concrete Structures and Technology at Imperial College. He is a Colonel in the Engineer and Railway Staff Corps and had six years distinguished war service in the Sappers including involvement with Mulberry Harbour and the big Rhine Bridges. A pioneer in the use of prestressed concrete in UK, a former Member of Council of the Institution of Civil Engineers, President of the Institution of Structural Engineers and member of the PSA Board since 1976, he is well known as an outspoken controversial humorist.

INTRODUCTION

He comes up to me and he says "Write me an article on the future of the Royal Engineers" and he walks away laughing and talking. Who was that then? That was Major General John Woollett, that's who that was. Then you'd better put your skates on. Too true.

I feel like an Old Testament prophet who has been summoned by the King and told "now prophesy", save that I am not a prophet of the Old Testament, nor, indeed, of any other sort. I reach for the nearest crystal ball—but it's on the blink or upside down or something. Perhaps the difference between prophet and professor got blurred that evening.

To start off with, I admit that I am not in the confidence of NATO nor of the General Staff nor of the Government; for all I know we won't have an Army in ten years' time. I realise that the art and mystery of Port Construction, in which I was once engaged, is old hat and that the British Army will travel to any likely war on the Harwich Ferry, so I suppose I shall not sell many floating breakwaters. But if I assume that the Corps will continue in its classic role of helping the Army to live, to move and to fight, it may be that a few odds and ends from a practising civil and structural engineer on recent developments may provoke reflections of utility—or, if not of utility, of health-giving mirth. Above all, let it be realised that innovation requires the exercise first of the imaginative faculty, then of the critical faculty. Both are essential; in this exercise the imaginative has played a preponderent role; criticism will come later (or, more likely, sooner).

BRIDGING

Assault bridging at the moment is a matter of prefabrication and assembly. As for assembly, the Bailey Bridge introduced the only novel method of bridge construction since prehistory—that which is now grandly known as the "incremental method", that in which the bridge is built at the back and pushed out over the gap in front. (I repeat, the only *novel* method. Prefabricated spans, in-situ construction, either on falsework supported on the ground or on an erection girder, cantilever construction, construction off a suspension cable—all are known since time immemorial). Now there are only three ways of assembling structural elements together so as to carry

Colonel A J Harris CBE

tension—molecular adhesion (gluing, welding), mechanical interlock (dogs, keys, pins) and prestress (tensioned bolts, tendons). Time will probably always exclude gluing and welding, particularly the time needed for preparation of the joints and for their inspection, though there might be a future in friction welding; the pin at the moment reigns supreme and has done since the Small Box Girder; what of prestress?

It is familiar in the minor form of the rivet and the bolt—neither of these rely for their working strength on their shear value, but rather on the force which they apply to two lapping sheets. The technique has become systematic and controllable with the torsion spanner and the load-registering washer, but is not novel; it was the foundation of the Callender-Hamilton Bridge, and, indeed, in a different manner, of the Inglis Bridge. For the moment, one can see no particular attraction in the method; it is labour intensive and time consuming. Perhaps with very long bolts doing several jobs at once? Perhaps not.

But the use of tendons disposed longitudinally and providing the major tensile strength can profit from a peculiarity of assault bridges which is that they are *temporary*.

In the first place, for a bridge whose period of service is measured in weeks rather than in scores of years, the problem of the protection against corrosion of a high tensile tendon is not grave. Some protection will be needed, but not much. Tendons can thus be arranged externally to the structure and used to assemble prefabricated elements with the minimum of attention to joints, which could be simple plain butting surfaces with some shear interlock or register. The difficulties associated with the stressing-on of successive elements as the bridge is launched incrementally can be overcome; the joints too could be either machined or use work-hardening metal shims—lead, for instance.

But it is the second possibility which could be most attractive.

In a permanent structure, one shuns the use of mechanism—look what happens to so simple a piece of mechanism as the expansion joint. In these days of micro-processors, however, simple readily programmed mechanisms can be relied upon for moderate periods, particularly if inspection and replacement can be provided with little difficulty—the black box approach.

What I have in mind is, typically, a series of identical segments with a tendon which would initially be axial; jacks supported on the deck would bear on the tendon in a vertical direction acting either up or down; these jacks would be linked with sensors (load cells or strain gauges or laser beams) so that as a bending moment is applied, *the tendon is deflected vertically*, using energy stored in a pressure vessel topped up by a small source of power, thus increasing the effective moment arm. (The force in the tendon could itself be varied, but these forces are at least an order of magnitude higher than those needed to deflect the tendon).

At the limit, the tendon would be deflected into the shape of the funicular of the load, leaving the deck to support only axial compression plus secondary bending and shear between the jacks. Clearly, the greater the headroom available for deflecting the tendons, the smaller the forces entailed; it seems likely that during launching, one would restrict the tendon deflection to within the depth of the deck—indeed it might be desirable to launch with axial tendons—but under live load, more might be acceptable. It is interesting that in this hypothetical limiting condition, there would be no vertical deflection of the deck, only a horizontal shortening as the load was applied.

An interesting design problem, with intriguing dynamic aspects, but not beyond the wit of man.

It will be noted that an arrangement of this sort leaves the deck free of primary tensile stress; choice of material is thus much wider than with the classic pin-assembled structure. There is always a trade-off in these matters; weight against cost; stiffness against slenderness; ease of construction against versatility of assembly, etc etc. Now that we can face making concrete of a strength of the order of 100kN/mm^2 and now that we know the criteria of acceptability governing triaxial stressing, we are

within reach of designing structures of weight comparable to that of steel, possibly lighter—and a great deal of labour can be expended on a concrete artifact before its cost per ton approaches that of steel. But I confess that I have no feeling for the cost-effectiveness of structure in equipment bridging.

The idea is, of course, equally applicable to wet gap bridging and could be used to restrict the deflection of the deck. This would increase the bending moments but, by bringing into play a greater length of buoyant structure, would decrease the total buoyancy needed. By and large, a structure capable of supporting bending is more readily transportable than is a structure capable of supplying uplift when immersed.

Indeed, the transport of buoyancy is a cumbersome business, if only because of the sheer volume entailed. The German M pontoon trucks, the Russian PMP (or "ribbon") equipment, the French rafting equipment, all require a specially equipped 5 Ton truck for something like 6m of bridge. Whatever their ease of transport and assembly (and their times of change from road mode to raft mode vary greatly) they all have something of the dinosaur about them.

What of instant buoyancy? Air is the cheapest commodity; much progress has been made these last few years with air-supported structures as robust high-tensile fabrics and reliable means of jointing them have become available. Not that this form of pre-stressing is novel; the application of tension to a membrane by inflation in order that it might carry compression has been long familiar in the form of the pneumatic tyre. Christchurch has produced a convincing inflatable bridge for a dry gap of 10m as well as other intriguing devices. When are we going to get a real ribbon bridge? Something that can be unrolled straight into the water, being inflated as it goes? Doubtless a wearing surface would be needed, doubtless also supplementary longitudinal bending strength for the heavier loadings, either of the classic passive type or using the active concept sketched out above.

There are also foamed plastics. When Major Alwyn Jennings-Bramly, RE, was working with my firm he produced an interesting scheme for a floating bridge using a flexible membrane filled with foamed plastic. Polyurethane can be dosed to foam and set in a period between seconds and minutes; the buoyancy is thus transported at a specific gravity of approximately 1·6 and is used at approximately 0·03. As an alternative to Alywn's idea, foamed plastics could be combined with some light collapsible box device to constitute the floats with decking arrangements similar to those with inflated flotation.

A once only device, of course; the foam is not to be de-foamed and put back in the tin.

FIELD WORKS

Early in 1941 one heard stories of attempts to reverse the processes of stabilisation of soil and hence, by *de-stabilising* it, produce an instant bog to the dismay of attacking tanks. Nothing much seems to have come of it (perhaps because the bloody-mindedness of nature resists the search for instability as fiercely as it does that for stability) but these days the use of bentonite clay offers, perhaps, a useful prospect.

We know the basic idea of the use of bentonite; a hole is dug and the walls of the hole are maintained by a bentonite slurry which exerts hydraulic pressure on the walls of the hole in which it is contained thus preventing collapse; the near colloidal fluid is too viscous to flow through porous ground, helped by a filtration process whereby particles of the bentonite are held by the ground and soon clog up the porosities. A series of trenches tactically disposed would be perfectly stable until the arrival of a large concentrated load as from a tank, when the walls would collapse into the bentonite and drop the tank with them. Is this a way of denying an area of ground to access by tanks?

Even a covering of a thin layer of bentonite slurry over a slope could, by virtue of its low coefficient of friction, prevent tanks from climbing the slope. Whilst the former device would be permanent, the latter could well be a device operated only in time of attack.

Reinforced earth has been with us for a year or so; the reinforcement consists of rods or membranes typically lying horizontally and anchored to the surrounding earth by friction. Old-timers will see in this art and science a generalization of the use of sandbags. Now a problem in the design in reinforced earth of permanent structures is the provision of permanent tensile strength in the reinforcement, which must not be subject to corrosion or decay. In combat engineering, this problem is less grave and woven sheets of synthetic fibres serve adequately. Such material is easy to transport and, in combination with the powerful means of muck-shifting at the disposal of the RE, offers the ability to build rapidly vertical earth faces of considerable height.

There are other uses for reinforced earth than this, of course. One such is the use of a layer of fabric beneath the working surface of a dirt road at a depth determined according to the nature of the dirt. The construction of such a road is clearly more complicated than the simple laying of trackway, but the fabric guards against failure of the foundation.

Why don't they use calcium chloride accelerated Portland cement for repairing scabbing damage in runways after cannon fire attack? The stuff can set in anything upward of 20 seconds—and it's cheap.

The need for protection is always with us. We have the Chobham armour, ideal for tanks but expensive for static protection. Concrete is the classic solution, but is cumbersome; we know more now, however, than we used to about the behaviour of concrete subjected to tri-axial stress and we can make concrete elements which are very hard and highly resistant to penetration whilst being capable of dissipating large amounts of energy. Hard and tough, in fact; characteristics hitherto regarded as incompatible.

MANAGEMENT

Some time in 1944, I was told (erroneously, for all I know) of the revolution brought about in Artillery survey by bright systems analysts from Cambridge, who appreciated that shot falls over a fairly extensive beaten zone and concluded that super accuracy in field survey was unnecessary. The consequence, it seems, was a considerable speeding up of survey in the face of the enemy; exact triangulation followed later.

Much thought has been given lately to this sort of problem—the acceptance of inexactitude and of uncertainty; their effects on reliability; the optimisation of decisions. The mathematical concepts are well-developed and the tools, in the form of compact, inexpensive computers, are now available.

Take a practical example. The President of the Institution of Bubble Blowers hears a hilarious story from the guest of honour after the lunch of the Association of Nitpickers (800 present). What are the chances that he can tell the story himself at the Dinner-Dance of the Feather Pluckers Association three days later (400 present, half of them ladies) and rely on it that 95% of them (or whatever his personal tolerance figure is) should not have heard it recently? Some of the Nitpickers belong to the Feather Pluckers but some of the Nitpickers didn't quite catch the punchline, some didn't see the point first time and some were making a book on the side on the length of the speech and were not listening anyhow. Moreover, how long before such Nitpickers as heard and understood tell the story to such Feather Pluckers as were not there? Weighty matters, none of them susceptible to exact estimation.

The solution to the problem, of course, (and readers who attend such functions will be delighted to know that it is in hand) is to set up the Presidents of Engineering Institutions Cooperative Executive (PEICE) with a central computer and data bank, issuing a weekly (and highly confidential) news sheet containing the values of the parameters for the field based on the theory of fuzzy sets so that members may feed them in to their pocket computers during the meal and get a best estimate of the tactical situation. No comical anecdote will thus ever be recounted by any member which is not novel to 95% of his audience—and if speeches are thereby made shorter, who is grumbling?

A less intellectual problem. A firm takes delivery of roughly prepared tree trunks and turns them out as telegraph poles. How are they to be graded? To test one in twenty to destruction is expensive—and who is to say that one has not broken all the strongest poles? It so happens that one is able to establish a rough correlation between the strength of the timber and each of a number of characteristics such as density, modulus of elasticity and the penetration of a standard steel spike. A rig is set up in which *every* incoming pole is rapidly measured, weighed, penetration-tested, loaded over a gauge length and deflections recorded; the results are fed into a computer programmed to answer whether the pole has a 90% probability of satisfying a certain defined criterion of strength.

Now the significant point is that the maths is complicated enough to be laborious even in a single case but that to set up a computer to cope with *every* case is a trivial task, whether from the point of view of complexity or of expense. Every week there is a reduction in the cost of computers; these days one can get a computer of immense power for little more than the equivalent of what one paid before the war for a really *pukka* slide rule. Not only are they getting cheaper, they are getting more compact; the RE officer may well go into action with an REPB in one pocket and a computer in the other.

Does this sort of thing reduce the initiative and the ability to improvise? In my view not necessarily, any more than the Bailey Bridge was to be seen as destroying skill in stick-and-string bridging (in fact, it supplied a new component for improvisation)—any more indeed than the computer infringes on the intellectual freedom of the structural designer. On the contrary, increased power of analysis increases the designer's freedom to think about what he ought to be thinking about—function, ease of construction, economy—uninhibited by fears that he might be unable to do the sums. Perhaps one should say that it *could* so leave him free; engineers can be so hyponotized by computers that they think that they have solved a problem when they have only written a programme. A useful rule-of-thumb—the use of computers gets dangerous when you cannot look at the answer and tell by inspection whether or not it is about right.

What sort of problems in the life of the serving Sapper officer will prove amenable to this sort of treatment? I have not the slightest idea. There are so many problems, however, where a quick decision has to be made on the basis of extensive but inexact information, that I would be greatly surprised if some such problem did not justify the preparation of a computer programme. Fuzzy sets might be our salvation.

FOOTNOTE

How's that, John? Yes, yes, of course. I do see what you mean. Sorry.

Merry-Go-Round

BRIGADIER J Á NOTLEY MBE

The author was a Tp Comd in N Africa and Italy, 2IC Fd Sqn in Greece and BAOR, Adjutant in TA and Trg Regts, Staff Capt RSME, Fd Sqn Comd in Greece and UK, GSO2 in Bahrain and in RECDS, 2IC Div Engrs in BAOR, CO in N Ireland, GSO1 MOD, Col GS in MOD and BAOR and was Comd ESG.

SAPPER officers are continuously being encouraged to write articles for the *RE Journal*, and coming to the end of my service I am aware that I have not really done my share in the past thirty-six years, having had one article published, one rejected on security grounds, one put in the waste paper basket, and finally, one which I got someone else to write!

In considering what to write about, I decided that it might be of some interest to give my personal views on a number of controversial subjects which crop up from time to time over one's career.

ORGANIZATION OF UNITS

The organization of engineer units is debated at frequent intervals and over the years has produced many different solutions. When I joined the Corps we had a CRE (Lieutenant Colonel) with a small supporting headquarters at divisional headquarters. He usually commanded three field companies and a field park company, but was quite happy to have further companies added to his command. All companies were virtually independent in that they ran their own administration, MT, G1098, pay and accounts. They could, without any increments of men or material, go anywhere on their own. This organization had been in operation for many years and worked extremely well. Soon after the war we formed regiments, I have never discovered the reason for this, but presumably it had something to do with accommodation. The CRE lived with his squadrons in the same barracks and had a representative at divisional headquarters. Squadrons were still pretty independent except that they usually had to "lend" men to the regimental headquarters to ensure that it could survive.

This arrangement worked well and some time later in BAOR was changed back to the old system with the CRE back at divisional headquarters, whereas in UK the commanding officer remained with his squadrons as he had no division to support. Further change occurred in BAOR when the CRE was returned to live with his squadrons. Still all was pretty sensible. However, madness was on its way, and we suddenly produced mini-regiments in BAOR, each under command of a brigade and a CRE at divisional headquarters. UK luckily had nothing to do with this plan and continued to have viable regiments. The new BAOR plan reduced the level of command of both commanding officers and squadron commanders, and at times commanding officers had only one or two troops to command while the squadron commander had the same couple of troops. It created a situation where a young troop commander had his OC, CO and CRE standing over him when he was doing an interesting job, as they had nothing more important to do. It also clouded some officers' ideas as to what was a viable command for a sapper Lieutenant Colonel, and created vast overheads in the numerous regimental headquarters.

Some sanity reappeared in the middle of the 1970's and we got back to a decent sized regiment. However, we had suddenly acquired a one-over-one organization with the CRE and CO duplicating each other. There the situation rests, but hopefully not forever. We should go back to the 1939 organization modified for 1980 operations. I am glad to say that I have found that nearly all sapper officers consider that the squadron is the most important unit in the Corps, and that it should be fairly independent. As long as this remains so the squadron will be able to cope with all the various systems it has to put up with to command it.

COMMAND AND CONTROL

In conjunction with organization goes command and control of engineer units. My first CRE, who was a very wise man, said that no sapper sub-unit, at any level, should ever be under command of a company, battalion, armoured regiment, or brigade, as other arms never knew how to use it properly. Sappers should always be "in support", available to do the work, having advised the commander how it should be done, and having the right to go one up on the sapper net if he would not listen. As a platoon commander in Italy during the war, my brigade commander, a most excellent

Guardsman, made it quite clear to all his battalion commanders that sapper officers were always right.

Today divisional and field force commanders seem to believe that they own their sappers, lock, stock and barrel. I believe we must go back to supporting formations and being able to get our higher formation engineer commander to have the last say on how we are used. This never used to cause any problems with other arms or the Staff, and they should now be educated to operate it again.

DEVELOPMENT OF EQUIPMENT

In the Corps we are, or should be, very concerned with the equipment we are given to carry out our tasks. I do not believe that the present system allows the regimental officer to state at an early stage what he actually wants. Research and Development Establishments are given a General Staff Requirement (GSR) which, in theory, has been cleared by engineer commanders. In practice it is very difficult from a piece of paper to really understand what you are going to get, and what the penalties are for agreeing to all the requirements in the GSR. In some cases, such as Ordnance vehicles built for engineer use, I do not believe that engineer commanders always see the GSR. It is difficult to believe that any engineer in his right mind would have agreed to the trailer which has been produced to carry the spare Armoured Vehicle Launched Bridges. Even with engineer equipment such as the Medium Girder Bridge (MGB) pier it is difficult to believe that the real problems of this equipment could have been understood from the GSR.

There is a very real requirement for Research and Development designers to explain their problems and solutions to engineer commanders at all levels when they are at the back of an envelope design stage, or at the very latest, the mockup stage of a new piece of equipment. I have found a definite reluctance in Research and Development Establishments to do this until a prototype has been produced for trial. Units then have to accept it or get nothing for the next five years. I am convinced that BAOR and UKLF engineers should be much more critical at this stage and if they are not happy with the equipment they should throw the whole thing back to the designer, but it would be much better if the user and designer could get together at a much earlier stage.

We should also develop a system whereby the Corps is allowed to develop its own equipment which is required in a time frame quite beyond the Research and Development system. This could be produced in engineer workshops and, although it might have minor failings, it would be available in the time frame when it was actually required. To do this would mean by-passing some of the archaic bureaucracy that we now have to go through. We have officers with very excellent ideas, a technical backup which can check these ideas, and workshops which can produce the goods.

TRAINING

The task of training our officers and soldiers is bound to be one of the main problems in peacetime. Over the years we have changed our officer training very considerably, and throughout all these changes I have always been convinced that the most important part of officer training is at least two uninterrupted years as a troop commander, at an age before he is married or thinking of obtaining other qualifications. I believe that this is more important than a long YO course, and should take place before he goes off to get a degree.

Most people in the Corps are now agreed that officers who can get a good degree should do so, but those who would only obtain a mediocre one would spend this time more usefully in regimental service.

For the non-PQE (Professionally Qualified Engineer) officer I believe that the Staff College is vital, certainly if he has ideas of reaching a reasonably high rank in the Army. Of course, officers have done this without *psc*, but it is a lot easier if you have these magic letters after your name.

Similarly with our soldiers, I believe the most important part of their training is two years in a field section, hopefully in command for some of this time. Northern Ireland has been very useful in training section commanders to lead but it has prevented squadrons from being fully trained for their priority one role. Training has been made more difficult because every squadron always has men away detached, on leave, courses, or working for RHQ, and this makes training less realistic for a troop reduced to ten to fifteen actual working numbers. I feel it is a pity we have reduced the size of our squadrons by nearly 100 men since the end of the war when a troop commander really had something to command.

There are those who consider that our soldiers are over-trained. This may be so on paper, but I am not convinced that it is a bad thing to have corporals who can take over a staff sergeant's job at any time, and I certainly have never suffered from having too many high grade tradesmen when undertaking a project.

On the whole, I believe we are a very well trained Corps, and should, if anything, put more emphasis on gaining experience in squadrons rather than attending numerous courses.

QUALITY OF LIFE

One hears a lot about the quality of life in the Army today, and the general impression is that it is on the wane. This is probably true but the reasons are not only pay and overstretch, which obviously contribute, but I believe that two other major factors are equally important.

The first is the fact that more and more officers and soldiers buy their own houses, settle their families into them, and then soldier unaccompanied even in units in UK. The lives of these men is a continual battle of living in a mess or a barrack room, or some small uncomfortable bed-sitter during the week and dashing home at weekends, even from units in BAOR. This kind of unsettled life does nothing for the individual and it certainly does not improve the general social life of units. I believe that the Army is a much more enjoyable career if you take your family with you whenever and wherever you can, even if you end up living in a tent.

Secondly, we do not allow our NCOs and officers to go and get on with their jobs without constant supervision, sometimes from three or four echelons above them. This causes everyone more work and does not create a realistic atmosphere on the job. The reasons are easy to see, the rat race is fierce and even troop commanders are unable to let a section commander get on with his job while he goes away and plays rugby, in case the NCO makes a nonsense and he is blamed by his squadron commander. In peacetime we must accept some disasters at all levels, it is certainly one of the best ways of learning how not to do a job. However, if commanding officers are going to get castigated because a section commander makes a mistake, then we will continue to have command from much too high a level and this in fact causes the quality of life to suffer.

CIVILIANIZATION

One of my pet hobby horses is the over-civilianization of the Army. For some time there has been a great cry, especially from the Civil Service, that a civilian is cheaper than a soldier. What they failed to add was that most soldiers are eventually replaced by three or more civilians and the loss of flexibility is enormous. We should now begin a long and protracted battle to *militarize* some of the posts that we have lost, regain some flexibility, and with luck reduce some bureaucracy.

CONCLUSION

I have never regretted joining the Army and in the past thirty-six years have not found another job that I would rather have done. It is an exciting, interesting and rewarding life and I am most thankful that my father, who was a Gunner in both World Wars, advised me to join the Sappers.

Scatterable Mines—The New Anti-Mobility Weapon for the 1980s

LIEUT-COLONEL N M WHITE RE, BSc (Eng)

Lieut-Colonel N M White RE, BSc, psc, odc(Aus) was commissioned in 1953. He attended RMCS 1954–57, Staff College Camberley 1964, JSSC (Australia) 1975. His recent appointments include GSO2, HQ 1(BR) Corps (1970–72); CO 72 Engr Regt (V) (1972–75); GSO1, DCD (A) (1975–78) and is currently GSO1 Tactics, RSME. He has served in Cyprus, Aden, Borneo, Singapore and Germany.

Acknowledgements:
Figures 1 to 7 are published by courtesy of Honeywell Inc Defence Systems Division. Figures 8 to 11 are published by courtesy of Dynamit Nobel AG.

"A SCATTERABLE mine is a mine laid without regard to classical pattern, that is designed to be delivered by aircraft, artillery, missile or ground dispenser or hand thrown." *Draft definition for AAP-6(N) 1978.*

INTRODUCTION

In recent years, the concept of remotely emplacing mines by delivery systems ranging from artillery and aircraft to short range vehicle mounted dispensers has been a favourite topic of discussion for military futurologists. It is a concept which will have a significant effect on the conduct of the all arms battle and one which attracts a wide range of different views in the Army. To the sapper, the idea of a remotely delivered mine conjures up a vision of the "instant obstacle" which is urgently needed to fill a serious gap in the present day counter-mobility capability. To the gunners, the artillery delivered mine is seen as a means of greatly increasing their contribution to the anti-armour battle. To the armoured corps and infantry soldier, the prospect of a battlefield littered with thousands of unmarked mines which could seriously interfere with their mobility, fills them with concern: particularly as to how the command and control of such minelaying systems will be exercised in a rapidly changing tactical situation. Finally, to the airmen, air-delivered mines provide another means of increasing the flexibility of their multi-million pound strike aircraft which will help to justify their value against land based anti-armour systems.

However, whilst there has been considerable talk on the subject of scatterable mines, little has been written, and as far as the author is aware this is the first article on scatterable mines to appear in a British military journal. The timing is none too soon since the age of the scatterable mine has almost arrived and is no longer a far off gleam in the combat developer's eye. In the past decade, whilst we in the UK have concentrated our minewarfare research efforts into making the barmine the best conventional anti-tank mine in the world, the USA and the FRG (Federal Republic of Germany) have devoted considerable effort to the development of scatterable mine systems and will, in the early 1980s, have a family of delivery systems in service.

It is the author's view that the introduction of scatterable mine systems to the future battlefield will be of great tactical significance and represents a milestone in minewarfare technology. Scatterable mines will add a valuable new weapon system

Lieut Colonel N M White RE BSc

to the battlefield commander's armoury that will be complementary to, but not a replacement for, conventional minelaying which will continue to provide the sinews of divisional obstacle plans. As the Royal Engineers are the arm primarily concerned with counter-mobility, it is important that the implications of this forthcoming innovation in minewarfare technology should be fully understood and opened up for general discussion. It is hoped that this article will help achieve this goal.

The article is in two parts. Part I briefly describes, as far as can be deduced from unclassified material, the present state of scatterable mine development programmes in the USA and the FRG. Other western countries, including the UK, are working on scatterable mine projects but so far have not made as much progress. Part II discusses the significance of scatterable mines on the future battlefield and examines the tactical aspects of their use, including some of their limitations.

PART I

CURRENT STATE OF DEVELOPMENT OF SCATTERABLE MINE SYSTEMS IN USA AND FRG

USA Scatterable Mine Systems

The United States programme for the development of a family of scatterable mines known as FASCAM has been in operation since the early 1960s. The types of mine in the family, with their corresponding delivery systems, are summarised in the following table:

SYSTEM	DELIVERY SYSTEM
M-56	Helicopter/UTTAS
RAAMS (Remote Anti-armour Mine System)	155mm Howitzer
ADAM (Artillery Delivered Anti-personnel Mine)	155mm Howitzer
GEMSS (Ground Emplaced Mine Scattering System)	Towed Dispenser
GATOR	High-speed Aircraft
MOPMS (Modular Packed Mine System)	Hand-Emplaced Pack

All the mines in the FASCAM programme are designed to self-destruct at times that vary from hours to days; the details of these timings are classified. The outline operating characteristics of each system are given in the following paragraphs.

M-56 Helicopter/UTTAS Aircraft Delivered System. (See figure 1). This system

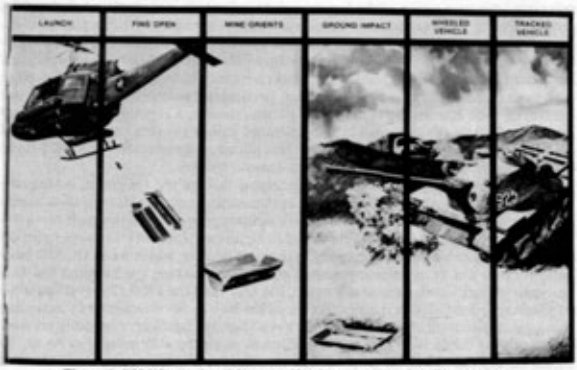

Figure 1. M56 Operational System—Deployment, Arming, Detonation

Scatterable Mines - The New Anti Mobility Weapon (1)

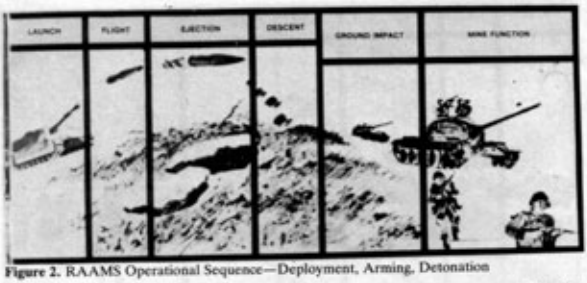

Figure 2. RAAMS Operational Sequence—Deployment, Arming, Detonation

dispenses the M-34 anti-tank mine either from a UH-1 helicopter or a UTTAS aircraft. The mine is activated by a pressure fuse and is capable of breaking a tank track. Twenty per cent of the stock of M-34 mines have an anti-handling mechanism incorporated in them. One helicopter on one sortie can lay 160 mines to produce a minefield strip 300 metres long by 20 metres wide with less than ten seconds helicopter exposure time over the target. The size and density of mines in a strip depends on the speed and altitude of the aircraft, which are varied according to the battlefield commander's operational requirements. The system is now in service with the US Army in Germany and one third of all UH-1 helicopters are equipped to deliver M-34 mines. It provides the US Army with the capability of emplacing small or medium-sized minefields with a considerably faster response time than that available with conventionally laid systems. The principal limitations of the system, in addition to the fact that the mine has no full tank width attack capability, are the vulnerability of the helicopters to enemy air defence weapons and the limited helicopter assets available in the division. The system is regarded as an interim one until the other mines in the FASCAM series are developed.

Remote Anti-armour Mine system (RAAMS). (See figure 2). This is an artillery delivered system which uses the 155mm Howitzer to project XM-70 and XM-73 anti-tank mines into a target area at ranges up to 17km. The only difference between the two types of mine is in the length of their self-destruct time. The mine weighs approximately 2·26kg (5 pounds) and 9 are carried in a 155mm projectile. Arming occurs automatically when the mine lands on the ground and actuation is achieved by a magnetic influence fuse which gives the mine a full width tank attack capability. Twenty per cent of all mines being produced will have an anti-handling device incorporated. The mine's explosive effect utilizes a shaped charge principle and is claimed to be capable of penetrating the belly of a tank causing a spalling effect inside which will kill or seriously injure the crew. The mine is also claimed to be able to destroy any tank track or wheel passing over it. The size and density of artillery laid minefields can be adjusted according to the target appreciation and the availability of artillery 155mm tubes. As a yardstick a single battery of six howitzers can provide in two volleys a minefield 350 metres wide by 250 metres deep with twelve rounds giving an average density of 0·31 mines per metre of front. This is the first artillery delivered anti-tank mine system to be developed. The project is in full scale development and the mines should go into production before the end of the decade.

Artillery Delivered Anti-personnel Mine (ADAM). (See figure 3). This system is complementary to RAAMS. M-67 and M-72 anti-personnel mines are carried to the target in a 155mm howitzer projectile. Each projectile can carry about 45 mines. The M-67 mine weighs 0·42kg (1lb), has a short self-destruct time and is activated by a trip wire mechanism which causes the mine to "pop up" and detonate. The M-72 mine has similar characteristics except that it has a longer self-destruct time. The

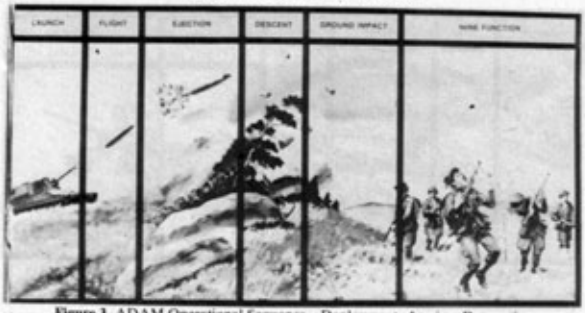

Figure 3. ADAM Operational Sequence—Deployment, Arming, Detonation

system is already in service with the US artillery units in Germany.

Ground Emplaced Mine Scattering System (GEMSS). (See figure 4). The GEMSS short range dispensing system consists of three major components: The XM-75 anti-tank mine, the XM-74 anti-personnel mine and the XM-128 mine dispenser. The XM-75 is claimed to attack tanks and vehicles in the same manner as the RAAMS mine either by penetrating the belly of the target or destroying its track or wheel. The XM-74 is the same size and round shape as the XM-75 and is activated by a trip wire mechanism. It is highly lethal against personnel targets and has some effectiveness against unarmoured vehicles. The XM-128 is a special purpose trailer designed to store, transport and scatter the two mines in various patterns, densities and mixtures. It can be towed by any tracked or wheeled vehicle of 5 tons or greater. The dispenser holds 800 mines, either all anti-tank or half anti-tank and half anti-personnel mines. Both types of mine can be dispensed at the same time and the operator is able to alter independently the rate at which each type of mine is projected thus varying the mix of anti-tank to anti-personnel mines. As with RAAMS and ADAM, the mines are automatically armed after landing on the ground. They can be dispensed at a rate of up to two mines per second and are projected to a distance of 40 metres from the dispenser vehicle. A minefield of several thousand mines can be laid within an hour with a 3–5 man crew (vehicle driver, control panel operator and others to help during reloading). Reloading the

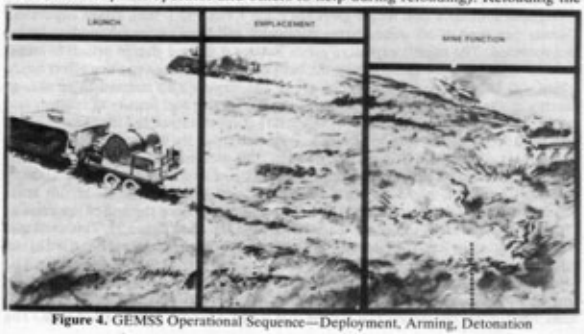

Figure 4. GEMSS Operational Sequence—Deployment, Arming, Detonation

Scatterable Mines - The New Anti Mobility Weapon (3 & 4)

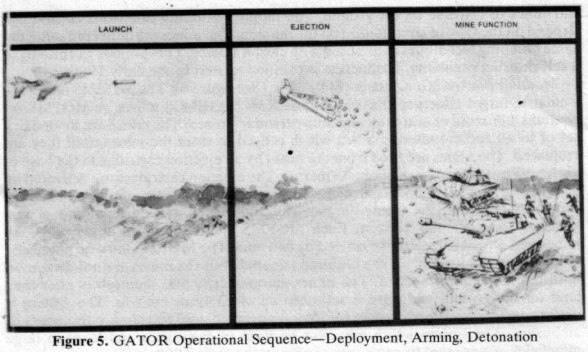

Figure 5. GATOR Operational Sequence—Deployment, Arming, Detonation

dispenser takes 10–15 minutes. The system is in full-scale development and is planned to be ready for deployment to units in the early 1980s when it will be issued on a scale of one to each combat engineer company. It will significantly increase the counter-mobility capability of the US combat engineers.

Tactical Air Delivery System (GATOR). (See figure 5). The GATOR system is designed for the emplacement of anti-tank and anti-personnel mines from high performance aircraft. The mines have a similar effect to the RAAMS and ADAM mines previously described. It is a joint service project and the system is being designed for use by Air Force, Navy and Marine Corps aircraft. 230 mines will be carried in disposable cannisters which when dropped from the aircraft, open, causing

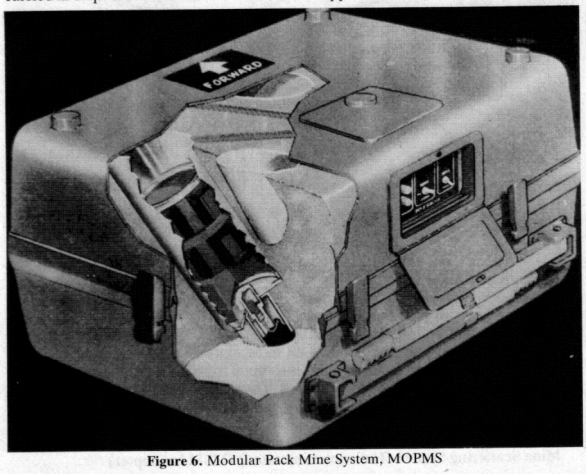

Figure 6. Modular Pack Mine System, MOPMS

Scatterable Mines - The New Anti Mobility Weapon (5 & 6)

the mines to disperse on the ground. The number of bomb cannisters carried will depend on the type of aircraft used on the mission. The mines are delivered using the same bombing techniques as are used with cluster bombs. These mines will also have a self-destruct capability. Production is planned to start in the early 1980s.

Modular Packed Mine System (MOPMS). (See figure 6). The MOPMS mines are similar in target effects to the XM-74 and XM-75 GEMSS mines. A MOPMS set contains a mixture of anti-tank and anti-personnel mines. The mines are loaded in a set of tubes and mounted in a box which is used to store the mines until they are emplaced. The mines are fired from the tubes by an ejection cartridge in the base of each tube out to a range of about 35 metres. The ejection cartridges are activated by an operator, using a remote control mechanism. The tubes are mounted in the box in such a manner that the ejected mines will land on the ground in a random and generally semi-circular pattern. Each MOPMS container holds between 10–30 mines and is light enough to be carried by two men. The MOPMS must be physically emplaced in the location of the required minefield but the mines are not dispensed until the minefield is needed. The mines automatically arm themselves after they land on the ground and have a self-destruct mechanism built in. The system is designed to be employed mainly for close-in defence, and to enhance the effect of ambushes. The system which may also be used to close gaps and lanes in large minefields, is expected to come into service in the early 1980s.

Figure 7. The FASCAM Concept

FRG Scatterable Mine Systems

The FRG is planning to introduce three delivery systems for their AT II mine (see figure 8) into service with the Bundeswehr in the early 1980s. The AT II mine is actuated against the belly of a target and by means of a vertical wire sensor. It is larger with more explosive than the US XM-70 mine and has a self-destruct capability which can be varied from 6–96 hours. It is claimed to be able to penetrate the belly plate of any known tank or destroy its track. The three systems under development which are briefly described in the following paragraphs are:

110 SF Rocket Launcher System (LAR)
Mine Scattering System (Vehicle mounted) (M730)
Mine Scattering System (Helicopter mounted) (MSM helicopter)

The FRG also intends in the longer term to use their Medium Rocket Weapon System (MRLS) to deliver AT II mines.

110 SF Rocket Launcher (LAR). (See figure 9). The LAR system has been in service with the Bundeswehr since 1969. One LAR rocket can carry 5 AT II mines and a salvo of 36 rockets can deliver 180 mines into the target area in 18 seconds. The mines are ejected from a flight stabilised mine dispenser unit and their descent to the ground is controlled by a parachute which is discarded on impact. The system is designed to give the artillery an obstacle-producing capability. It is expected to be in service with the Bundeswehr in the early 1980s.

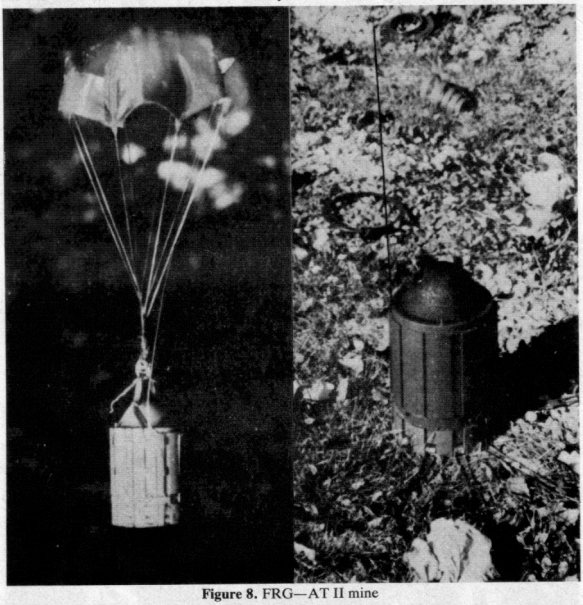

Figure 8. FRG—AT II mine

Mine Scattering System (Vehicle Mounted) M730. (See figure 10). The system, which will be lightly armoured, is operated by a crew of 2–4 sappers and each brigade engineer company is to have four M730s on establishment. It consists of a tracked vehicle chassis on which is mounted six dispensers each containing 100 AT II mines. The dispensers are operated electronically and can be adjusted in a horizontal and vertical plane to alter the range and pattern of the scattered mines. It is possible to fire two magazines, one on each side of the vehicle, simultaneously. The mines are projected out to a distance of about 20 metres, and the density of the mine pattern depends on the speed at which the M730 operates. This can vary from walking speed up to 25km/h. The time taken to reload a dispenser is approximately 10 minutes. It is estimated that one panel of 600 mines in a 3000 metre long strip which has a density of 0·2 mines per metre frontage, will give a stopping power of 65 per cent. The system is designed to give the brigade engineers a quick reaction minelaying capability.

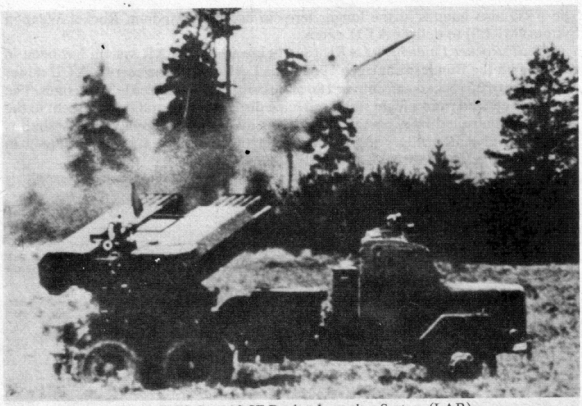

Figure 9. FRG—110 SF Rocket Launcher System (LAR)

Mine Scattering System (Helicopter). (See figure 11). This delivery system is basically similar in operation to the US M-56 system except that the mines have a full width tank attack capability. The system can be mounted on any UH-1 or UH-1H helicopter. One helicopter with two dispensing magazines can carry 200 AT II mines. A 500 metre strip with 0·4 mines per metre of frontage can be laid in 20 seconds at a speed of 20 knots. Some doubt exists as to whether this system will be accepted into service with the Bundeswehr.

Figure 10. FRG—Mine Scattering System (M730)

Scatterable Mines - The New Anti Mobility Weapon
(9 & 10)

Figure 11. FRG—Mine Scattering System (MSM Helicopter)

PART II

THE SIGNIFICANCE OF SCATTERABLE MINES ON THE BATTLEFIELD AND THEIR TACTICAL EMPLOYMENT

Background—The Need for Scatterable Mines.

Current Soviet offensive doctrine is based on the concept of *Blitzkrieg*, that is to say the use of massive concentrations of armour supported by powerful artillery and air forces against the weakest point in an enemy's defence. Such a concept demands for its success a strong inherent mobility in the forces taking part, otherwise their momentum will be rapidly lost and the attack will grind to a halt. Perceiving this, the Soviets regard the maintenance of mobility as a primary principle of war and provide their forces with excellent rapid minefield breaching and gap crossing capabilities. In the face of this threat, the ability of the military engineers in NATO to degrade the mobility of the enemy armoured forces is therefore of paramount importance. Without a good obstacle-producing capability to slow down and filter attacking enemy armour, NATO's heavily outnumbered direct fire and indirect fire weapon systems would be quickly swamped and possibly overrun. The present day Corps tactical concept envisages that the majority of pre-planned minefields and demolitions required by the armoured divisions will be completed before hostilities break out. The time required for these barrier preparations is measured in days rather than in hours and they are implemented according to a complicated and relatively inflexible plan which is very expensive in terms of engineer manpower and resources. The plan is also subject to political constraints which dictate at what stage of the build up in pre-war tension barrier preparations can begin.

There are some serious disadvantages to this concept from a tactical point of view. First, if the enemy crosses the border with a minimum of warning, the armoured divisions will have to fight without a completed obstacle plan. This would be particularly serious in defended areas where no good natural obstacles exist. Furthermore, once battle is joined the ability of the divisional engineers to produce minefields in the forward areas will be seriously degraded because of the relatively slow response times of the barmine laying system and its vulnerability to enemy air and ground attack. Any minelaying which it is possible to carry out will probably have to be done either at night, when fast laying times are difficult to achieve, or in rear areas where the chance of enemy interference is less. A second, but less serious, disadvantage is that minefields laid before the battle starts may be discernible to enemy air or satellite surveillance means and an analysis of their layout does to some extent compromise the Corps defensive framework, although it can equally be said that if an

enemy is forced to take minefields into account he is, in effect, beginning to conform to the defender's design for battle. Thirdly, and perhaps most importantly, it is possible that much of the enormous engineer effort devoted to the emplacement of conventional minefields will have been wasted if it is laid in the wrong place because of a tactical misappreciation of the enemy's intentions. Finally, whatever warning NATO receives of an impending enemy attack, it is unlikely that there will be sufficient time available for her forces to prepare fully their conventional barriers and defensive positions. An enemy which relies so much on mobility to ensure its success would be most unlikely to allow this to happen.

From this brief reflection on the use of obstacles in the Corps battle, it is concluded that the lack of a rapid obstacle-producing means which is complementary to the slower conventional obstacle systems, represents a most serious gap in our current operational capability. This gap is likely to worsen in the years ahead as the warning time of an enemy attack reduces and his armour and obstacle-breaching systems become progressively more sophisticated. It is the author's contention that scatterable mine systems with their greatly improved response times, particulary those using rocket or artillery delivery means, will fill this gap and give the future commander a much better overall anti-armour capability. It will give him an asset which he has never had before: the means of degrading terrain over which an enemy force is moving or is about to move, when and for as long as he chooses according to the operational requirements. The fast response times of scatterable mine delivery systems, coupled with variable self-destruct periods for the mines which can be chosen to suit the tactical situation, will in effect give the commander an "anti-mobility" weapon which he can optimize with his direct and indirect fire weapons to achieve maximum attrition of the enemy. Scatterable systems will also make the future commander less reliant on pre-planned conventional obstacles which may or may not have been completed or indeed may be sited in the wrong place. Thus the true significance of the introduction of scatterable mines to the battlefield can now be seen. For the first time the counter-mobility capability, with its new found dynamism, will become an integral part of the battle and will no longer be regarded as a separate entity to the anti-armour capability which it so often is at present. Having established the importance of this innovation in minewarfare, it is now time to look briefly at the operating characteristics of scatterable mine systems.

The Mines

Scatterable anti-tank mines are of necessity designed to be smaller than conventional anti-tank mines so that they will fit into shells, rockets or dispensers and can be projected to the required range. They contain only a small amount of explosive and rely for their effect on a shaped charge principle which it is known gives a penetrative effect against armour. Such small mines will obviously not produce the catastrophic destructive effects which can be achieved by mines like barmine, which contain over five times as much explosive: it is the author's opinion that they are unlikely to produce more than a mobility kill in spite of some of the more ambitious claims made by their developers. However, at the time of writing, the UK has not yet had the opportunity to evaluate the lethality of the US FASCAM mines so this can only be surmise.

Delivery Systems

There are three broad categories of delivery system. First, those systems which can deliver mines in response to an immediate battlefield request, with the same speed and flexibility as supporting artillery. Examples of this type of system are the gun, rocket and aircraft. Such systems are unlikely to be used to lay large-scale minefields because they would not be cost effective in terms of the great quantities of mines required and the limited resources available to deliver them: their use will be confined primarily to the production of small point type minefields in the face of, or on top of, identified enemy armoured forces. An example of the size of template of a scatterable minefield of this type is 250 × 350 metres. In the second category are quick reaction delivery systems, such as those mounted on helicopters or vehicles:

these can be used either on a pre-planned basis for large-scale scattered minelaying or at short notice in the face of a developing enemy threat, such as the closing of an enemy minefield breach. Examples of these delivery systems are the US M-56 or GEMSS. Because of their vulnerability these systems would not normally be used in contact with the enemy or where they would come under observed fire. The third category are hand emplaced systems, such as the US MOPMS, which can be used on a pre-planned basis to close defiles and lanes in minefields. It is envisaged that the second and third categories would be operated by engineers whilst the first is clearly an artillery or air force responsibility.

Effectiveness of Scatterable Mines

It is important to be clear about the differences between conventional anti-tank minefields and minefields laid using scatterable delivery systems. Conventional minefields, using buried barmines with a wide range of fuze options, present a difficult problem to enemy breaching forces as well as a strong deterrent to their tank crews because of the high lethality of the mines. Scatterable mines, which are surface laid and less powerful in their explosive effect against armour, will not be technically as difficult to clear and will probably have less of a deterrent effect on the enemy. The main value from scatterable mines is derived on the battlefield from the surprise they achieve against an enemy force when they appear without warning and where their effectiveness can be considerably enhanced by battlefield conditions such as the type of terrain, obscuration effects and the amount of covering fire being brought to bear. An enemy commander faced by scatterable mines will be forced to choose between "bulling" through and risking casualties or stopping and calling up his mine-clearing devices which will increase his exposure time to the defender's covering fire. The former course is dangerous since trials have shown that surface laid mines are very difficult to detect by a tank commander or driver, particularly when a tank is closed down, being shot at and moving across country. Another important difference between the two types of minefield is that the conventional minefield once it is laid remains a barrier until it is lifted, whilst the effectiveness of a scatterable mine minefield is dependent upon the self destruct timings of the mines laid in it. This has obvious implications for barrier preparations carried out during a period of tension when it may become necessary to leave mines in the ground for long periods.

The inescapable conclusion is that the scatterable mine cannot be regarded as an alternative to the conventional anti-tank mine but as complementary to it. Scatterable mines should therefore be used primarily as a means of temporarily degrading the enemy mobility by stopping tanks and restricting their movement, but not as a means for producing minefields with a similar stopping power to that achieved by our present tactical minefields. It is significant that both the USA and the FRG have recently acknowledged the need for strong conventional minefields and are now beginning to investigate ways of improving their conventional anti-tank mine capability.

Tactical Use of Scatterable Mines on the Battlefield

From the preceding paragraphs it is suggested that the role of scatterable mines may be summarized as follows: to provide the battlefield commander with an anti-mobility weapon system which is complementary to his anti-armour weapon systems and conventional minelaying systems; that is, capable of:

(a) Scattering mines in front of and amongst an advancing enemy force to stop tanks or restrict their movement so that they can be engaged more effectively by anti-armour weapons.

(b) Providing a rapid means for large scale surface minelaying and for improving the effectiveness of existing obstacles either on a pre-planned or an opportunity basis once battle is joined.

(c) Harassing enemy movement in rear areas.

Possible tasks for scatterable mines within the context of the paragraph above are:

(a) *Tasks in immediate support of operations.*

(1) Quick response obstacles in front of or on top of an enemy formation.

(2) Closing of defiles or gaps and lanes in minefields and assisting in achieving a clean break for withdrawing friendly forces.
(3) Separating enemy leading elements from follow-up and logistic forces.
(4) Interfering with enemy obstacle breaching operations.
(5) Disrupting enemy airborne or airmobile forces at DZs/LZs.

(b) *Pre-planned or Opportunity Tasks.*
(1) Large scale surface minelaying.
(2) Thickening up natural obstacles such as woods or soft going.
(3) Laying mines in areas unsuitable for mechanical minelaying means.
(4) Completing or thickening up existing conventional minefields.

(c) *Harassing Tasks.*
(1) Enemy amphibious crossing, bridge and ferry sites.
(2) Enemy artillery locations.
(3) Enemy HQ, harbour areas and FUPs.
(4) Enemy rear areas and MSRs.
(5) Key terrain—such as hides or vital ground.
(6) Forward enemy airfields.

In all artillery scatterable mine engagements the use of other natures such as smoke and HE (High Explosive) rounds will considerably add to the enemy's confusion and enhance the effectiveness of the mines. Advantage should also be taken of the use of darkness particularly when scatterable mines are used in a harassing role against long range targets. All scatterable minefields should, in the same way as conventional minefields, be covered by direct or indirect fire to achieve the most cost effective results.

Relating the above tasks broadly to the Aggressive Delay and Main Defence Phases of the Corps battle, the employment of scatterable mines might take the following pattern. In the Aggressive Delay Phase they should first be used to instil mine consciousness in the enemy as early as possible after he attacks to reduce the morale of his tank crews. They should be used against opportunity targets in the border area and in depth against his follow up formations. If the enemy attacks with little warning and there has been insufficient time to lay conventional pre-planned minefields, scatterable mines should be used to infest large areas in front of the enemy's most likely routes of advance. Whilst these minefields may have a limited stopping power, they will at least force the enemy to deploy his mine-clearing devices and slow down his rate of advance, thereby gaining more time for the Main Defence positions to be prepared. If there is sufficient time to lay strong conventional minefields, scatterable mines are likely to be used to improve them and in a harassing role against opportunity targets. As the battle switches to the Main Defence Phase, scatterable mines could be used to help the Aggressive Delay Force achieve a clean break. During the Main Defence Phase, the primary uses of scatterable mines will be against enemy breaches of the Corps conventional obstacle belts, in a harassing role against depth targets and in an emergency role to counter unexpected enemy thrusts. Scatterable mine engagements will be used most effectively in direct support of battlegroup operations where they will be laid within the framework of divisional obstacle plans.

Command and Control Aspects

It is the traditional function of the engineer staff in a headquarters to keep the General Staff up-to-date on the location and state of all the obstacles in the operational area. The authority for the siting and laying of obstacles at all levels is a commander's responsibility, acting as necessary on engineer advice. These principles are equally valid for scatterable minefields but their unique delivery characteristics pose some new command and control problems.

The type of scatterable mine engagement a commander wishes to execute will depend on the target appreciation, the time available for emplacement, the time the obstacle is required and the availability of the delivery systems. The last factor will often have to be evaluated against the requirements of other high priority tasks

competing for the same delivery means. The arrangements for the command and control of vehicle or helicopter scatterable mine systems should not pose any undue difficulty, but where there is a possibility of ambiguity is in the delivery of scatterable mines using artillery or air delivery systems. The reason for this is the "hybrid" nature of the long range delivered anti-tank mine which combines the characteristics of a rocket or a shell with those of a mine: the successful use of such a weapon therefore demands a close integration of ballistic and minewarfare techniques.

If it is accepted that scatterable mines are an anti-mobility weapon, it is considered indisputable that it should be an engineer responsibility to advise the commander on the position and type of scatterable minefield which would best satisfy his particular requirements. The engineer commander is the focal point of all obstacle planning within the operational area and it is only he who can accurately evaluate the suitability of the terrain for scatterable mines, advise on their location in relation to other obstacles in the area, assess the effectiveness of likely enemy mine counter-measures, and from his analysis recommend the size and density of the scatterable minefield required. However, whilst this principle should be applied for all pre-planned scatterable minefields it will not always be possible for the engagement of opportunity targets during operations. These types of engagement will need to be controlled in the same way as normal artillery support and batteries should be capable of delivering a number of standard scatterable mine obstacles, the choice of which will be dictated by the target appreciation. If time permits, the engineer adviser should be consulted, but this may not always be possible.

Next a word about the danger which scatterable mines pose to our own forces. The presence of our own and possibly the enemy's scatterable mines on the battlefield in large quantities presents a serious hazard to our mobility. The reporting and recording of scatterable minefields must therefore be meticulously carried out and disseminated to all levels which need to know by the fastest possible means. This information should contain the exact location of the minefield, how long it will remain active and what types of mine it contains. As ADP (Automatic Data Processing) systems enter service this process can be greatly streamlined with direct links between scatterable mine delivery systems and a central computer. As far as the marking of scatterable minefields is concerned, since they have a self-destruct capability, a less permanent means of marking than that used for conventional minefields will be required. At present there do not appear to be any systems under development for the marking of artillery or air delivered scatterable mines.

Some unanswered questions

This article has only been able to examine the use of scatterable mines in broad conceptual terms and has touched on some but by no means all of the problem areas. Four questions which will need to be answered in the near future if we are to bring scatterable mine systems into service are given below: readers can no doubt think of many more:

(a) Everything which has been written in this article so far has assumed that the US claims for the effectiveness of the FASCAM system are credible. If the UK is to buy into FASCAM, and it would appear to be the only readily available system, we will have to satisfy ourselves that the mines will be effective against the future range of Warsaw Pact tanks and mine counter-measures. What would be the effect, for example, if the next generation of Warsaw Pact tanks have stronger belly plates?

(b) What will be the status of scatterable mines in the eyes of the Geneva Convention? There are indications that they will be unacceptable because of the possibility of indiscriminate use which would endanger civilians. Should we disregard this view, or go ahead without considering the feelings of other nations?

(c) Assuming we do adopt scatterable mine systems, what proportion of artillery ammunition stocks should they take up in relation to other natures?

(d) This article has for obvious reasons been concerned only with the defensive use of scatterable mines. The Warsaw Pact forces with their large preponderance of multi-rocket artillery delivery systems is ideally equipped for the use of scatterable

mines on a massive scale. However, there is no evidence, as far as the author is aware, that the Soviets are developing scatterable mine systems but it would clearly be wrong to assume that they will not. Should we therefore be giving a higher priority to the provision of rapid minefield breaching systems than we do at present?

CONCLUSIONS

It is hoped that this article has at least given the reader some idea of the characteristics of the scatterable mine systems which are likely to be in service with the US and FRG Armies within the next few years and stimulated his interest in this important subject. There can be little doubt from the arguments presented about the urgent need for our forces to have scatterable mines as an essential part of our counter-mobility capability in the future. It is clear from the examination of the effectiveness of scatterable mines that they cannot be considered as a replacement for conventional anti-tank mines. It is envisaged that strong conventional anti-tank minefields will continue to be needed for the foreseeable future. Scatterable mines will provide a valuable complementary weapon system to conventional mines which will in effect give future commanders a reserve of uncommitted obstacles: they will also provide a valuable obstacle insurance policy should there be insufficient time to prepare conventional obstacles before an enemy attacks. The short response times of scatterable mine systems will make counter-mobility systems for the first time an integral part of the contact battle.

There are of course many problems related to the employment of scatterable minefields and in this article there has only been time to discuss a few of them: of these, those associated with command and control are perhaps the most difficult ones to solve. There is obviously a need for a close dialogue with the Royal Regiment who are about to enter the counter-mobility field in strength.

Finally I would like to close with a quotation from an article in the *RE Journal* published in 1924, (and republished in March 1974), by a Captain and Brevet Major (now Major General, retd) R H Dewing, DSO, MC, RE who wrote:

"*The framework of anti-tank defence under present conditions must be anti-tank artillery, but minefields may prove as important an accessory to these guns as barbed wire has proved to machine guns.*"

Will the introduction of scatterable mines have a similar effect on future tactics? It is the author's firm belief that they will.

* * * *

Centenary Meeting – 27th November 1975

COMMEMORATIVE COPIES

THE Centenary Meeting of the Institution of Royal Engineers was held on 27 November 1975. The *RE Journal* published an introductory article by Brigadier J H S Lacey CBE (Secretary of the Institution 1958–72), the Proceedings of the Meeting and a number of written contributions following the Meeting.

All these articles have been collected and have been bound in an attractive red cover as *Commemorative Copies of the Proceedings and Correspondence Inspired by the Meeting*. With each copy (in a pocket inside the back cover) is a Royal Engineers Special Commemorative Cover, hand stamped No 1487 dated 22 May 1975, the actual Centenary Day. Only one hundred of these Commemorative Copies have been produced, each is signed by the President of the Institution for authenticity. This will enhance the value of each copy.

They will be sold on a "first come first served" basis at £3.00 each. Applications to Secretary, Institution of Royal Engineers.

Sappers Fit For War

LIEUT-COLONEL W M R ADDISON RE, BSc

Lieut-Colonel Addison has served as a parachute sapper in the Near and Middle East, the Pacific, North America and Ulster, and as a commando in the Far East; when Confrontation ended, he and his QMSI were replaced by 59 Cdo Sqn. He was UN Liaison Officer to the Vice-President of Cyprus during the intercommunal fighting, a Whitehall Warrior and DS at the Canadian Staff College, before becoming CRE Northern Ireland. He is now Defence Fellow at St Antony's College, Oxford.

ROLE

WHAT is the role of Sappers in war? "To help the Army to live, move and fight"? Time honoured, but wrong: the ACC feeds, the RCT moves and nearly everyone fights. So what do we do that the others don't?

Where there is water and the tactical commander wishes there wasn't, the Sappers will create crossings for him; where the enemy has a clear run, obstacles; where there is open ground, protection from weapons and weather; where there is dirty water or none at all, clean; where there is darkness, light. So: Sappers change the face of the earth to suit the tactical commander's aim.

Given that our role is to change the face of the earth, the faster we do it the better, so we either achieve the desired result quickly or do more in a given time. Now change entails work and rate of change, power; since we are in the business of producing high rates of change it follows we must be capable of handling large amounts of power. It matters not whether the power comes from releasing the energy locked in explosives or fuels, behind dams or in mountains: to change the face of the earth, we are in the power game. The first essential element of military engineering is power.

Power must have something to act on, so materials form the second essential element of military engineering. Earth is by far our most common material: raw earth everywhere, cooked earth in bricks and concrete, hard earth of various sizes in roads, airfields, ports and nearly everything else. Earth isn't too strong in tension, so for that we use timber and steel. Our equipment bridges are of more exotic metals, and we are bound to make increasing use of composites and glass reinforced plastics, but by and large these are used in prefabricated structures and we build with them rather than in them. Water is our last important material, either for consumption or for engineering. So: the second essential element of military engineering is material, principally earth, concrete, steel, timber and water.

Now power and materials are useless unless we know what to do with them, and how to do it. *What* to do is determined by reconnaissance, appreciation, planning and design: intellectual skills. *How* to do it is a matter of artisan and command skills. All these skills are vested in men; nothing else will do. So: the third essential element of military engineering is skill.

To fulfil our role as military engineers and change the face of the earth we need these three things:

POWER
MATERIALS
SKILL

Lieut Colonel W M R Addison RE BSc

But civil engineers are also in business to change the face of the earth and also depend on these three. How does military engineering then differ from civil? The answer lies in the second part of our role: suiting the tactical commander's aim.

SUITING THE TACTICAL COMMANDER'S AIM

Probably before he decides his aim, and certainly before he decides how he is going to fulfil it, the tactical commander will discuss with his sapper the options the military engineer can offer him. Ideally, he wants an environment in which he can operate freely—go where he wants, when he wants, well supplied, protected from enemy observation and fire—and in which the enemy can do none of these things. Now the earth is neutral, a non-belligerent, so what suits one force will suit another. The only way of fulfilling this ideal is therefore to divide the land into two parts, one for you and one for him: you build your fortress on commanding terrain, complete with wells, grain stores, magazines and guns, flatten and flood the surrounding ground, fell all the woods within gun range, organize an early warning system among your peasants, and scorch the earth as you withdraw into your fortress.

Not so easy nowadays, when the countryside has been replaced by suburban sprawl, and forelock-tugging peasants by owner-occupiers not at all interested in cleared fields of fire, still less in fortresses which would quickly figure on the nuclear target list. In truth, it was never that easy, for sooner or later, if he wanted to win, the Lord had to ride out from his castle and engage the enemy on ground of the enemy's choosing.

The tactical commander is thus interested in what his sapper can do to make this shared battlefield most advantageous to him and least to the enemy—a less clear-cut, more difficult problem.

Modern weapons have ranges and terminal effects many times greater than those in World War II and mobility to match. The active area of a modern battlefield is therefore much greater than hitherto, and the changes that a sapper must be able to make to it, grander in scale.

Some such changes are irreversible within the likely span of the battle: the flooding of the Low Countries for example. Others are only reversible by using large proportions of very scarce resources (the destruction of the Rhine bridges); some are relatively easy to reverse (minefields, routed roads, cratered runways), but still need scarce resources and time.

The sapper is therefore choosing between options which are much broader than those open to the civil engineer, who is usually engaged to build something specific like a port. He may be given some choice over the exact location and facilities to be provided, but he wouldn't normally expect to be told he could build a canal or an airfield if he thought that would be better. Still less would he expect to be shown a vast tract of ground and asked for his advice on how to make it a better place to fight in.

Time presses harder on the military engineer: if the ground is now to belong to us, then to the enemy, then again to us, the changes we must make to it must be extremely rapid, and the decision making equally so.

The civil engineer is usually able to choose the most favourable ground, whereas the best ground will often be denied to the military engineer by the enemy. So the civil engineer builds his port at Le Havre, the military engineer a Mulberry in the raging seas of Arromanches; the civil engineer routes his motorway through the plain, while the sapper drives his counter-attack route through mountain, forest and swamp, to come upon the enemy from an unexpected direction. The civil engineer can order up his suspension cables, pre-stressed beams, and pre-fabricated caissons a year ahead to fit his "cascade": we must engineer with what we can get.

So compared with civil engineers we are coarse engineers, in both senses of the word: unsophisticated, and tough. Our engineering will never win the Queen's Award to Industry, nor appear in the Design Centre, but it takes place at the uttermost boundaries of the art: terrible terrain and weather, extremely short time-

scales, vast amounts of power, available materials, factors of safety of one, and with an enemy intent on destroying our work. In short, we should be experts in the extraordinary.

How well do we, the Royal Engineers, match up to these standards today? In the next section, I'd like to examine some of our current philosophies which I believe are dangerously out of date, driven as they are by a folk memory of sappering in bygone days, overlaid by thirty-three years without a major war.

SAPPER FOLK MYTHS

THE MYTH OF MANPOWER

Although the essential skills are exercised by men, and only by men, the word "manpower" has never so far been used in this article. For a very good reason: man *power* is a myth, and it is probably the most disabling myth in our Corps today. A man's value lies in his brain: a military engineer's body is worthless except as a vehicle for his skills. It is absolutely useless as a source of power. Even a highly trained heavy worker can only produce two or three hundred watts in continuous operation—about the same as a Black and Decker do-it-yourself drill—and perhaps two or three times that in a burst: less than a moped. Yet we persist in doing jobs by hand instead of pumping, craning, forking or dumping. We even publish articles in *The Sapper* about recruits "learning much about manual labour" by running barrows loaded with concrete for 200m across the bottom of the Basingstoke Canal. No wonder they "ended up with their knuckles dragging on the ground". That sort of thing may be done by small-time jobbing builders, and if they keep on doing it they will never be anything else, but it is absolutely useless as training for war.

Some would say we must get used to working without power and materials, as we will not get them in war. What nonsense. If we run out of power and materials we will lose, just as if we run out of ammunition. What after all is a rifle but a machine for throwing a missile further, faster and more accurately than you could do it by hand; a power tool whose fuel is called ammunition—and so are all weapons. For we sappers proudly to deny our utter dependence on power and materials—our ammunition—and even to train without them is utterly wrong. Revealingly, we love explosive—and it's literally the most powerful machine we use.

Furthermore working thus is horrendously wasteful in peace. A sapper in a working section costs some £50 a day to run, making realistic allowances for overheads—a figure, interestingly enough, not all that different from civilian costs per man. We ought to get at least £50 of value out of him in an average day spent sappering, but how often do we? For £50 we could buy a couple of hundred gallons of fuel, about a MW hour of electricity, half a dozen power drills, or rent a concrete pump.

Some would say the soldiers must be there anyway, so it doesn't matter whether we use them efficiently or not. My goodness what a lame excuse. Are we really so finely trained for war, so poised for the start, that we can afford to use our soldiers as if they were ballpens, sitting in a drawer till we need to use them? Are we really training our units for war if we teach them to waste their most precious resource, men, by using them not for their irreplaceable skills but for their easily replaceable and vastly expensive muscles?

We account for our PRI and pay down to the nearest penny, but how many units could account for what their men actually do, even down to the nearest man-year, which costs at least £10,000? How are the man-years available to a unit commander budgeted between leave, training, displays, projects, trade courses, shooting, exercises, operations and so on? Does anybody know what contribution each of these makes to his fitness for war? I bet nobody does, and I bet they would be horrified if they did.

An intuitive feel for it? Not true; a simple example: some squadrons are now being allocated £1,000 worth of materials for a three-week training period for their 60–80 working numbers, in other words about one-third of their manpower cost for a

day. A squadron in full cry ought to use twice that amount of material in a single day, so by spreading it over three weeks we are in effect teaching them to work twenty or thirty times too slowly. Now even if we can afford that in peace (and should we?) we cannot afford it in war; wasting time is the worst possible training for war.

Our sections are twice as big as they ought to be: there are very few jobs that need six or eight skilled men in one place, so what we do in practice is to use one or two for skill and the rest as machines: they then go home tired but happy and nobody notices how wasteful it has all been.

If we are to do our job in war we must be efficient; we cannot then be inefficient in peace: old habits die too hard. We must tackle big tasks that will exercise the skills we need in war. This of course needs money, but we are in the unique position in the Army that the output of our training is (or ought to be) more valuable than the input: we are not firing thousands of pounds down a range to end up with a hole in a target.

All very well, but perhaps engineering in combat is so different from engineering in peace that training can never be realistic. Let us see how that myth stands up to examination.

COMBAT ENGINEERING MYTHS

Once upon a time we were field engineers, but that didn't have enough machismo, so we became combat engineers; a big mistake, for combat and field engineering ceased to be synonymous, so that when people now talk of combat engineering they mean demolitions, mine warfare and equipment bridging: the sort of thing that is done on exercises in Germany.

Well to start with, combat engineering clearly means engineering in combat. Since the end of World War II, the British Army and the Royal Engineers have been in combat in Palestine, Korea, Malaya, Cyprus, Borneo, Aden, Muscat, the Radfan and a host of others. Demolitions, mine warfare and equipment bridging were not unknown in these campaigns, but they played minor parts. On the other hand several skills which are regarded by the present day "combat engineer" as construction (and therefore anathema to him) became vital: things like building airstrips and helipads on the tops of mountains, and sidehill cutting down one-in-one slopes. In the early days in Borneo a number of company bases were sited on low hills dominated by high ones simply because we lacked the skill and boldness to get up the mountains and build there, and even to pump water up the thousand feet to the top.

All this business of "combat" engineers and "combat" signallers is pretentious flannel: why not combat POMs, (Plant Operator Mechanic), combat surveyors and combat cooks? Field engineers fought throughout the World Wars in real combat. It debases the currency to change the name in peace, like awarding medals for exercises.

The Corps' present understanding of combat engineering and its distinction from construction engineering and projects is totally artificial, totally wrong and highly dangerous to our fitness for war. Military engineering is indivisible: every one of our techniques is used in combat at some time or other. If you think general war will be an exception (and who can tell, for no-one has ever fought one) ask yourself what happens on Day 3 or Day 30 or whichever it may be when the armies have battered each other to a standstill, as they did in the Yom Kippur War. Furthermore is it inconceiveable that the next war will not be on the Central Front, which now obsesses us? Will we be prepared if it isn't?

The combat engineer prides himself on being "soldier first, sapper second". What nonsense. Sappers *are* soldiers, so the phrase is meaningless. What the combat engineer means when he uses it is "Infantryman first, sapper second". Now there are lots of infantrymen about, trained and equipped for the job, mortars, missiles and all. There are never enough sappers, so we're told, so why try to turn ourselves into second-rate infantrymen when our job is to be first-rate sappers? Sappers play no less part in the all-arms team than the infantryman or cavalryman, and certainly get just as closely involved in the battle. So why hang on the hem of the infantryman's robe? Let's be proud to be ourselves and do our own job properly.

PQE (Professionally Qualified Engineer) MYTHS

The basic principles of engineering are exceedingly simple: every child practices them building sandcastles, toy forts or tree houses. Wind, water, gravity and knocks will defeat your structures unless they are built to certain rules.

On the other hand basic principles aren't enough when it comes to building an Albert Hall or Rhine Bridge, so that's why we have PQEs and Clerks of Works.

Nevertheless there is a continuum from sandcastle to military port: engineering doesn't fall into two neat groups, one for the professionals and the other for field engineers. However, this is what we've done in the Corps, or rather what has happened, because it's unlikely anyone ever intended to do it. The professional side of the Corps has come to be thought of as the destination for apple-cheeked boys from Chepstow and refugees from the rough and tumble of regimental life, while the rough Dover boys and squadron toughs want nothing to do with professional engineering nor engineers, lest they sully their machismo.

It does not help that the professionals have evolved a workstyle which might have been designed (and perhaps was) to keep the squadrons at arms length. We now have an exceedingly cumbersome, bumf-ridden system for planning even the simplest of tasks. After the briefest possible visit to *Earth*, the *Druids* retire to their *Temple* on Salisbury Plain and months later produce a beautiful limited edition of the *Bible*, bound with springy plastic fingers, tied with white ribbon, and full of words like "client" and "customer"—a language alien to the rest of the Corps. A suitable squadron is then chosen to set the book to music and perform it.

Now it may be fine for civil engineers to divide themselves into consultant and contractor in this way, but it is totally unnecessary and very disadvantageous for military engineers to work thus.

No-one can foresee all the problems that will arise during a project, nor can our PQEs solve them all on paper beforehand; certainly the squadrons can't solve them all without help. In any case the arm's length, step by step system is very time consuming and totally incompatible with the speed with which we must work in war. We must break down these artificial, self-erected barriers between the professional and regimental engineers and work hand in hand.

A professional military engineer should have the ability to design concurrently with the field engineers' work, so Stage 2 is being designed as Stage 1 is being constructed and so on. An imperfect system, to be sure, but we are after good fast engineering, not perfect slow engineering.

Of course it is right in peace to extend our professional skills by tackling very ambitious projects and taking them slower than we would in war, so we extend our skills, building up quality first and speed later. A chess player can always play draughts, but the reverse doesn't hold true. Nevertheless military engineers are draughts players, and if we insist on not playing if we can't play chess, we are not doing our job.

THE MYTH OF IMPROVISATION

Power and materials cost money; so does skill, but that's paid for already, so, as we have seen, we take it for granted and waste it.

There are only three inputs to an engineer task: skill (exercised by men), power (machines) and materials. The engineer commander must balance these three to do the job either in the shortest possible time, which is normally the case in war, or, in peacetime, for the least possible money. In practice there is often no difference.

In peacetime we have lots of men, a few machines and practically no materials. This simply reflects the relative ease of getting hold of them in time of war, but we tend to let this entirely artificial balance drive our activities in field engineering.

We think of improvisation as making do with what we've got, instead of what we could get. We train with a pool of bits and pieces to lash up into "improvised" structures. On the bridging hard lie a few railway sleepers with timber dogs and lashings artistically scattered around to look as if they were the sort of thing one could rely on finding at any old picnic site on the Weser. The kit is then assembled much like

an equipment bridge, the bankseats even fitting into the worn places on the bank and the dogs into their holes. Next is a pile of rusty oil drums, an old tarpaulin and more rope and sticks, to be fashioned into something bearing a passing resemblance to a raft. And next a heap of telegraph poles, blocks and more string, to make into an aerial ropeway capable of carrying a sack of cement or so.

All good fun, and not without merit for a squadron sports day or the regimental boy scouts, but completely useless as serious training for military engineers. Such techniques were fine when you could wrap up your section trek cart in its tarpaulin and float it across a river, or even sling your horse across on an aerial ropeway: indeed you will find drawings in the *Field Service Pocketbook 1914* (and earlier perhaps) which differ little from those in the current *FEMW* (Field Engineering and Mine Warfare) pamphlets.

Sticks and string engineering on such a scale is useless for modern war, so it is not surprising that not a single member of the audience in the 1977 E in C's Conference claimed ever to have built a field machine on operations, parbuckled or even found a use for the more exotic dozen of the knots even now enshrined in the combat engineer syllabus. We waste time on such frippery, and get our imaginations stuck in low gear.

RESOURCES MYTHS

Only a very good engineer can really improvise, and he needs backing up by an imaginative and efficient resources organisation.

Of the three essential elements of sappering—skill, power and materials—resources is responsible for two, and furthermore for the two that aren't there already waiting to be called.

Now our professional resources organization is very good, indeed many times better than we deserve. Resources in a field unit, however, is a different matter. What is the field engineer's impression of resources? We set the newest joined subaltern to command support troop while he's waiting for a field troop. We wait for the squadron command list with bated breath and trembling hands lest we get a support squadron instead of a field one. We push our ageing soldiers with bellies too big for an APC (Armoured Personnel Carrier) into our stores.

We'll get a fright in war.

From being neglected in a corner of the MT yard, quietly butchering wood into jumps for the horse show and wringing iron into gates for the general's garden, resources will find themselves dealing with vast quantities of material—not just accounting for it (which we are not too bad at but of course becomes the least important thing in war) but assessing its quality, fabricating it, transporting it and choosing substitutes.

Because machines and materials cost money we do without them in training, neglect our resources organization in the field, and fail to give them any experience of the scope and pace of their job in war.

TRAINING MYTHS

Unless we are on operations or on essential tasks such as sappering in Belize or fire-fighting, we are training, and for one thing only—war. It matters little to the sapper whether the war is general, limited or a counter insurgency campaign. In all of them his task is to change the face of the earth to suit his commander's aim, balancing skill, power and materials to produce the greatest possible result in the shortest possible time.

But we don't see it like that: we teach sappering as a series of drills—demolitions, bridging, roads . . . instead of teaching the basic skills common to all of these.

We are terribly prone to fragmenting our training into tiny bits, being drawn into trivia and losing sight of the overall aim—sappers fit for war.

It is not at all unusual to find tradesmen, even Class 1, who have never touched their trade except at Chatham. It is the rule rather than the exception to find plant operators who have never shifted any more serious muck in their lives than pushing sand from one end of Upnor to the other. They can operate and maintain the

machines they are familiar with, but can't apply the same principles to new machines, and certainly can't muckshift with the speed that we would need in war. Our Corps is overtrained at Chatham, and under-experienced in the field.

After thirty-three years without a shot being fired in anger in North West Europe—at least by conventional armies—exercises have come to be regarded as surrogates for war, and performance in them as the criterion for success. This is a most dangerous fallacy. Exercises have about as much relation to war as playing scales to piano sonatas—useful but dull, mechanical and over-simplified.

Exercises are particularly dangerous to sappers because the face of the earth cannot actually be changed during them, so white tape, plasticine and clothes line have to be used instead, and the inherent unreality is so obvious that even the other arms notice, and ignore even our modest attempts to play sapper factors realistically. We thus get so used to notional tasks and notional timings that our imaginations grow stunted and ossified, and we cease to appreciate the scale of sapper operations in war.

The assault across the Suez Canal in the Yom Kippur war involved crossing the 200 metre wide canal and breaching the 20 metre high bank forming part of the Bar-Lev fortifications by high pressure water jet. Not technically very complicated, though a 200 metre obstacle with hefty currents reversing direction with the tide might worry an inexperienced sapper troop commander. But look at the scale. Five Egyptian divisions took part in the assault—much the same as our corps in Germany. The Egyptian sappers opened sixty gaps in the sandbarrier, had fifty ferries and ten bridges across the canal by H + 8hrs and got 400 tanks across in the first twenty-four hours. Ten ferries and two bridges per division (though it didn't work out quite as neatly as that because the bank in one sector beat the sappers) plus shifting 20,000 cubic metres of sandbank per divisional front. Ten days later it was the Israelis' turn to cross the canal, and it took five days of bitter fighting, ferrying and bridging to get Sharon's division across.

Are our imaginations calibrated to operations on such a scale? And have we the skill, power and materials to match?

THE MYTH OF OVERSTRETCH

We only have two roles: war and preparing for it. There's only one mini-war on at the moment, and that occupies less than 10% of the Corps, leaving the other 90% training, less a handful deployed on quasi-operational tasks such as Belize. We have had thirty-three years of peace to get our contingency plans right and all the administrative preparations made, so we must have some 14,000 sappers with nothing to do all year long but prepare for war: we can't possibly be over-stretched.

But we are.

That can only mean we are doing something wrong, and of course we are: we fritter our time away on things which have nothing to do with getting ready for war. Displays, for instance. It cannot be right for a squadron to spend six weeks working up a morning's demonstration to the Staff College, nor for a division to spend months and millions on a Jubilee Parade. If we wanted to be showmen we should have joined Equity and not the sappers. We certainly ought not to spend weeks rehearsing so we can present ourselves as instant engineers, implanting in the watchers' minds a totally unrealistic conception of military engineering, which will serve them ill in war.

We spend far too much time on piddling tasks which never allow the troops to get up speed and have horrendous overheads. Furthermore, small tasks conceal inefficiency: we don't mind much if a job that ought to take a section a couple of days takes two sections a week. If it needed two squadrons instead of one, and five months instead of two, heads would roll and the recriminations would be heard for miles; but the scale of the inefficiency is identical.

We have a mania for cutting up our units into tiny bits and throwing lots of them away on activities that have little or nothing to do with preparation for war. Our units are supposed to be fit for war, but they can't be, because we keep taking the men away to schools which teach them what they ought to be doing in their unit—combat engineering, trades, fire prevention, audits, shooting, sport and even Christian

leadership for God's sake. Our officers clearly don't learn much in their units to fit them for war, because we have to drag them into classrooms for PQSs (Promotion Qualification Scheme) of one sort or another, ostensibly to do just that. Or would the young fellows actually learn something if we simply stopped disrupting the unit and let it do its job?

SO WHAT DO WE DO ABOUT IT?

This article has taken a crack at every element of the Corps, and since you belong to at least one of them you will by now be hopping mad at the unjust criticisms and distorted picture of your bit. But didn't you secretly agree about the *other* parts of the Corps? So what ought we to do?

TWENTY-ONE POINTS FOR DISCUSSION

(1) We must be clear about our aim: to be fit for our role in war.

(2) We must maintain our aim: examining all we do, assessing its contribution to the aim, and eliminating the activities which do not earn their keep. Overstretch is of our own making.

(3) We must be clear about our role: to change the face of the earth to suit the tactical commander's aim.

(4) We must appreciate how the vast improvements in the weapons, mobility and supporting infra-structure of modern armies demand a vast increase in the scope of sapper work in war, in its scale and in its speed.

(5) We must become experts in extraordinary engineering—very short time scales, poor terrain, terrible weather, extreme flexibility, very high efficiency, great power, all available materials, economical design to minimal factors of safety and against extraordinary threats. That is our job in war, and that's the way we'll earn the respect of our fellow civil engineers—not trailing along on their coat-tails but doing things that they can't.

(6) Sappers must be under sapper command. We have enough difficulty getting our own officers to use sappers properly, and to make use of our enormous flexibility, unbound by formation boundaries, which tactical commanders regard as Hadrian's Walls. Doling them out in penny packets to tactical commanders is wrong in principle, and runs counter to every lesson learnt in war.

(7) Our Corps must stand up for itself in the Army, advising on the potential of engineer operations in modern war, insisting on realistic military engineering in contingency plans and all-arms exercises, fighting for the share of the Army's resources which will optimize our contribution to operations. We're tacticians too.

(8) We must be much more imaginative in our approach to modern military engineering. Where are the modern fortifications and obstacles to match modern fire power and mobility? Can't we do better than wriggly tin, pickets and wire for our field defences? Is it conceivable that our handful of M2s will be enough in war; or what's left of our armoured engineers? Are there no better and swifter obstacles than minefields? How can we best use microprocessors to speed good decision-making?

(9) We must drag field engineering out of the Boer War, boy scout techniques which now fixate it, and force it into the 20th Century. Our officers must have a far greater understanding of the application of power. Our sappers must be able to operate and maintain any sort of engine, select the appropriate machines for a job and use them competently.

(10) We must train our units realistically for their roles in war. It is reasonably easy to train for our roles in counter insurgency because we've had at least one campaign going ever since the war. We have a realistic appreciation of the required skills and are able to practice them on worthwhile engineer exercises abroad. Our general war role is so wide ranging, speedy and messy that it is impossible to train for it in Germany; not even Suffield will do. We must develop engineer exercises elsewhere which realistically model the skills, power and material flow required in general war. We must stop wasting our time, boring our soldiers and stunting our

imaginations with white tape engineering, and mending farm gates or fences after the cavalry—playing the modern equivalent of the man with the bucket and spade for the horse droppings.

(11) We must not fritter away our time on little tasks; only big ones force us into efficiency.

(12) Our resources organization in the field must be given equally realistic training, and the people too. Theirs is a most difficult task in war and the one on which all others depend: supporting a handful of garages or horse jumps is not enough.

(13) The split between what has come to be called combat engineering and construction must be healed: it is totally artificial and very dangerous to our preparedness for war. It is all field engineering.

(14) Similarly, the rift between PQEs and field engineers must be filled. PQEs must work hand in hand with squadrons, not at arm's length. They must be prepared to design swiftly, and concurrently with the field engineers' work. They are an integral part of the Corps, neither civil engineers nor consultants. They must not act as if they were: that is not what they would have to do in war.

(15) We must stop teaching our sappers drills, and concentrate on the basic skills of all military engineering:

Reconnaissance
Planning
Working to line and level
From simple drawings
In concrete, steel, timber, earth and water
Using machines
Efficiently
Economically
Safely
Fast.

(16) We must make far better use of our men, for their skills and not for their trivial muscle power or fire power.

(17) We must teach our officers to balance the elements of military engineering—skill, power and materials—to do their tasks in the shortest possible time or at the least possible cost, whichever rules.

(18) We must so bring up our young officers that they are useful members of the unit immediately they join it. If they cannot produce the goods on arrival they are simply, if unconsciously, bypassed. The squadron commander and troop NCOs do the troop commander's job between them, and he never learns.

(19) We must stop our officers and soldiers being over-trained and under-experienced. The more we send them on courses the less time they have to gain experience at regimental duty and the more we disrupt their units and prevent them running realistic training on a large enough scale to teach proper lessons for war.

(20) We must stop fragmenting our units and posting our officers and soldiers at a frenetic pace. Turbulence is a self-inflicted injury. Now we have four field regiments in Germany and four in GB whose geographical distribution roughly parallels the distribution of non-field and ERE posts, can't we home-port the members of our Corps on Ripon, Waterbeach, Salisbury Plain or the Medway, so they can buy houses, settle their children into schools and their wives into jobs, and expect to return there after postings to BAOR and abroad?

(21) We must look after our officers and soldiers much better than we do, or we will have none left. Why don't we help ourselves, pull ourselves up by our own boot-straps? For example why don't we form unit housing cooperatives, buy land on the open market, build houses in our spare time and sell them to the soldiers in the cooperative with a Building Society mortgage?

FOOD FOR THOUGHT?

For Those Interested in the Chinese Language

COLONEL E JACOBS-LARKCOM CBE

Born in 1895, the author was commissioned into the Corps in 1916. His first Far East tour was in Hong Kong 1919–22 with 40 Fortress Coy. During this tour he spent four months with the Legation Guard, Peking and two months in W and SW China. 1925–28 saw him based on Hong Kong again with spells of duty in Shanghai & Tientsin. In WW2, having been evacuated from Dunkirk, he worked on decoys until mid-1942 when he was posted as 2IC British Military Mission to China in Chunking. From Oct 42 to Sep 45 he was in command of an Officer Group attached to General Li Mo-an's Group Army. During this period he worked in sixteen out of eighteen "Old China" provinces. He transferred to the Foreign Service, by agreement with the War Office, in 1946 and served as Consul or Consul General in Harbin (Changchun), Kunming, Tamsui (Formosa) and Chiengmai (Siam) until Dec 1958 when he retired from the Foreign Service.

Most people believe that the Chinese language is immensely difficult, and consists of hundreds of different dialects which effectively prevent adequate communication even between Chinese themselves. Neither of these statements is entirely correct. One of the fundamental facts about Chinese is that the written language is common to all dialects. So any literate Chinese, from any part of China, can communicate in writing with any other literate Chinese.

But to learn the written language is a formidable task. There is no alphabet, and each word is represented by an *ideograph* (or character) which must be memorised. An educated Chinese would recognise 5000 or so such characters, but one could scrape through the reading of a newspaper with 2000, and the use of a dictionary. It must be conceded that to master the writing demands time, a good memory and dogged determination.

This leaves out of account the *ts'ao tzu*, the "grass" character or running hand, an art which seems to be reserved for those who are born Chinese. I should explain that the grass character is an abbreviated form of writing used by educated Chinese to save time. It achieves this end by eliminating some of the strokes of a character altogether, and by not lifting pen from paper except when essential to do so. There is no standardized system, although there are principles which are generally followed. However individuals usually develop their own particular tricks and quirks, so that it is extremely difficult—sometimes impossible—even for a Chinese to read an unfamiliar hand. I have not yet met a non-Chinese who has mastered the art of either reading or writing the grass hand.

As for the dialect situation, it is not generally realized that nine-tenths of the population of China acknowledge some form of Mandarin as their mother tongue. The dialect speaking areas form only a narrow belt, like the coloured rim of a saucer, stretching from the Vietnam border to the Yangtze river. In many places it is a mere hundred miles or so wide, and the change from dialect speaking areas to Mandarin country is abrupt. This was very noticeable when travelling by train from coastal

Colonel E Jacobs-Larkcom CBE

Shanghai to Nanking, a little over 200 miles inland: the change from dialect to Mandarin occurs about half-way along the route.

That the predominance of the dialects is exaggerated is probably due to two factors. Firstly, because historically early contacts and trade were largely confined to dialect speaking areas (eg Canton, Foochow, Ningpo); and secondly, because today most westerners meet Chinese, and form their impressions of the Chinese, outside real China—in Hong Kong, Singapore, Chinatown in San Francisco etc. And these Chinese and their forbears are emigrants who came almost exclusively from dialect speaking districts.

But dialects are certainly a hindrance to the easy exchange of ideas and more than once, to save the use of pen and paper, I have found myself in the strange position of interpreting between two Chinese. On one occasion I had to interpret between the Ministry of Foreign Affairs representative in Kunming, who spoke Mandarin and impeccable French, and a well known lawyer and government official from Hong Kong, who spoke Cantonese and perfect English!

The following remarks on the spoken language refer to Mandarin which, often with marked differences in accent, is spoken from the Burmese border in the extreme south-west to the Russian border in the extreme north-east, and covers a vast area of the hinterland of China. A curious variation which occurs between different districts is the frequent interchange of initial consonants. The development of this quirk is no doubt facilitated by the absence of an alphabet which in itself would tend to check divergence from the path of orthodoxy. Whilst examples of the interchange of philologically closely related consonants are common in other languages (eg *d* for *t*, *sg* for *k*) those that occur in Chinese are often unexpected and cover a wider field. For example, *shui* (water) becomes *fei* in Shensi, and in Hunan the use of *l* and *n* are reversed. This gives rise to the well-worn joke against the Hunanese gentleman who, when asked how many children he had, replied "*I ko lan ti, i ko lu ti*", which in standard Mandarin would translate "one blue one and one green one"! Reverse the consonants and the meaning would be—as intended—"a boy and a girl".

Chinese is basically an easy language to speak. It has no inflexions, no tenses, the same form for singular or plural, the same word serves unchanged as noun, verb, adjective or adverb, and so on. All you have to do is to string your words together in a logical sequence, always remembering that relative pronouns—although existent—are rarely used, and dependent clauses are picked up bodily and set down as an adjectival phrase before the noun, followed by the magic little genitive particle *ti*.

All languages, however, have their impishly contrived entanglements. It may be pronunciation, the use of tenses or prepositions, or some other awkward factor. As for Mandarin, I believe that the overwhelming difficulty stems from the paucity of sounds (ie words) available in a monosyllabic language. In the form of Mandarin spoken in Peking, there are just over 400 sounds. Multiply these by the four tones used (five in some other parts of the country) and you get at most 1600 different single syllable words to cope with modern vocabularies. Many of these 1600 words are only finely distinguishable one from the other. The result is that many words and expressions are identical or nearly so, with consequent confusion and misunderstanding.

One ludicrous aspect of this problem is to see two educated Chinese talking together who, to save lengthy explanations, will "write" a character in the air on their hand! This is immediately intelligible, whereas the spoken word could be ambiguous or meaningless. To give an idea of the extent of the problem, *Matthews' Chinese-English Dictionary* (which is by no means exhaustive in its scope), lists 135 characters with the sound *i*, of which seventy-one are in the fourth tone and therefore identical in pronunciation. No wonder the foreigner has to have great mental agility to unravel the meaning of the spoken word! A solution is showing itself in the increasing use of two-character or three-character words, thus in effect changing the language from a monosyllabic to a polysyllabic one. But the process is by no means yet complete. Could it lead to the atrophy of tones and eventually to their disuse?

There can be no doubt that the system of ideographs used in Chinese writing is archaic, time absorbing (both in learning and using) and cumbersome. It is a complete mystery to anyone brought up on an alphabet based language. Think of such every day essentials as typing, filing and indexing. There is of course, no inherent difficulty in "romanising" Chinese. So why have the Chinese themselves clung to a system which must be a drag on progress and efficiency in innumerable ways?

The reasons are probably twofold. Firstly, a system of romanisation can only express the sound and tone of a character and not necessarily its meaning—hence the educated Chinese having to supplement their speech by sign writing. Secondly, the sheer beauty of the writing has an irresistible appeal to those who are steeped in its use. It is interesting to note that the Japanese also retain the Chinese characters, although here there is no problem in romanising their polysyllabic, non-tonal language—indeed they have their own ready-made syllabaries to hand. And the Japanese, with their closer involvement with modern industry, are more in search of efficiency and speed than the Chinese. Yet in spite of all its drawbacks, they have kept their traditional writing.

Now a word on tones—a conception entirely foreign to the speakers of European languages. A tone is an inflexion in the mode of speaking a word. It may be rising, high, low, snapped off abruptly, or long drawn out. If you alter the tone, you alter the meaning of the word. "Buy" can become "sell". So beware of anger and emotion! Some Europeans quickly become sensitive to tones, whereas others never make progress and always have problems in speaking and understanding a tonal language.

There are numerous stories about the wrong use of tones. Many, as might be expected, are unprintable. But I will relate one from my own early experiences when still learning Chinese. At that time I was stationed in Hong Kong, learning Cantonese in my leisure hours and enjoying the ownership of a small yacht. One day I was doing a job on the rigging when I found I needed a brass block (pulley). As there was none in stock at the boat-yard, I set forth to try to buy one in the town, having first ascertained the Cantone expression for it—*t'ung lo*.

Outside the yard, I tackled the first likely-looking passer-by who, somewhat to my surprise, immediately broke into a broad friendly grin and offered to guide me in my search for a *t'ung lo*. After a long walk we arrived at a shop selling Chinese musical instruments, whereupon my guide triumphantly pointed to a huge brass gong! In Cantonese *lo* in a different tone—means "gong"!

And finally, I'd like to mention a development which has occurred in one of the Chinese dialects—Amoy—the origin and advantages of which elude me. I'm referring to the automatic changes of tone in the Amoy dialect. If you ask an Amoy dialect speaker to pronounce a single character he will do so giving it its "basic" tone. That this is the "correct" one is borne out in nearly all cases by its easily traced affinity to the tone of the same character in Mandarin. But when the character is used in a sentence in Amoy, it is subjected to a fixed and arbitrary change of tone, with one exception, when it is the final word.

Thus in a sentence of six words, five will be spoken in the variant tone, and only the sixth will be pronounced "correctly". In other dialects, variations of tone occur for reasons of euphony or ease of speaking. A common example of this is in the sequence of two third tone words in the speech of Peking, the first of which is always spoken in the second tone to avoid the awkwardness and unpleasing effect of one long rising tone followed immediately by another. But no such considerations apply to the Amoy dialect. How could these strange rules have originated? And what benefit are they?

These random observations on the Chinese language make no claim to be erudite. They are merely a sample of notable and curious aspects of Chinese, of which I became aware in the course of many years acquaintance with the language.

* * * *

Remote Control of Earthmoving Equipment

CAPTAIN C E E SLOAN RE, BEng(Hons)

The author was commissioned in 1968 and his pre-YO attachment was with 2 Div Engr Regt in BAOR. His first unit appointment was as Fd Tp Comd, 16 Fd Sqn of 23 Engr Regt in 1969. In 1972 he was posted as SI Plant at AA Coll Chepstow. In 1974 he became 21C 52 Fd Sqn (Airfds) involved in Airfield Damage Repair and Construction as well as more conventional construction in Gibraltar. Now attending Staff College, this article, the third to be published in the RE Journal, *is based on an Advanced Study undertaken whilst at RMCS, Shrivenham.*

AN AWAKENING

Robots have returned to popularity with the success of recent science fiction films. Readers of technical journals, even watchers of serious television, will be aware that what the space novelist writes is not far from reality. An enormous expansion in the application of microprocessors has enabled complicated electro-mechanical linkages to assist, sometimes replace, man in performing a variety of tasks.

The recognition of the value of industrial robots, and their widespread implementation, has not occurred in Britain to the extent that it has in other developed nations like Germany, Japan or the United States. In these countries robots have been used as paint-sprayers, load carriers in automated warehouses, welders and on car assembly lines. It is not on their accurate, reliable and tireless operation that this article wishes to concentrate.

What is seen as of greatest value to the military engineer is their ability to work in unpleasant and dangerous conditions. Sadly, the high value that is placed on life by Western nations is not reflected throughout the world. However, in the West it must be expected that society will become more and more reluctant to ask its individual members to risk their lives on its behalf. Even soldiers may not be expected to make the sacrifices that their predecessors accepted as a normal requirement. In any event, every step should be taken to protect and safeguard the life and well-being of any person facing a hazardous situation. Mechanical aids to this effect have already been seen. The Wheelbarrow remote handling equipment for dealing with terrorist devices has saved many lives in Northern Ireland. Unmanned submersibles carry out inspection and construction tasks in lieu of deep-sea divers. A start has been made in harnessing the potential of automatic or remotely-controlled machines to help man. There are as yet many areas in which the value of such assistance has not been recognized. Military plant is one such area.

SOME APPLICATIONS

For many years it has been Army policy to purchase earth-moving equipment from the existing commercial market. Perhaps is should be expected that little military attention will be paid to remotely-controlled equipments until precedents have been set in civilian practice. Yet this is already the case. Marubeni-Komatsu offer no less than twenty-seven bulldozers and tracked loaders that are readily modified for remoted operation. Since 1969 the US Steel Company have been using a Caterpillar

Captain C E E Sloan RE B Eng

tracked loader under remote control to remove hot slag from furnace areas.

Current use of remote control of large machines is not restricted to conventional earthmoving equipment. Atlas Copco provide British mines with excavators that are controlled by a distant operator via a length of heavy duty cable (Photo 1). This permits the efficient removal of coal from areas that would be too small or dangerous for a manned excavator to operate in. Due to the falling availability of labour willing to work on the land, farming has become an industry in which remote or automatic control of motorized equipment is necessary. The National Institute of Agricultural Engineering has succeeded in developing a tractor that can plough a field by itself once it has ploughed a furrow under manual control.

Many earthmoving operations can be hazardous, uncomfortable and unpleasantly repetitive. Felling trees, working close to a quarry face and operating on a side-hill cut are but three areas of potential danger to an operator. Extremes of temperature and ripping hard ground would be obvious causes of operator discomfort. Simple, repetitive tasks, such as loading dump trucks from a stock-pile, are executed with reducing efficiency as the operator becomes bored with his recurrent routine. Remote control would alleviate these problems on both civilian and military sites. There are, in addition, specifically military tasks that call for remote control. These are outlined below:

Barrier Removal. The removal of obstructions to mobility is a requirement in normal operations and under counter insurgency conditions. Road blocks, for example, could be covered by fire or booby-trapped. A powerful, robust machine would be able to remove the barrier with no risk to the life of the operator (Photo 2). The equipment currently in use in Northern Ireland to deal with barricades is a lightly armoured, wheeled machine that is susceptible to many forms of terrorist attack. Other than in, so far, unique and exceptional circumstances the AVRE has not been an acceptable replacement for "Scooby Doo". There should be no political or other constraint on using a remotely-controlled bulldozer to deal with blockades or barricades in conventional or internal security operations.

Toxic Environment. In the event of nuclear warfare it may be necessary to decontaminate specific, vital areas of ground by the removal of radio-active soil. A similar requirement could occur in peacetime if a nuclear accident should result in contamination of the surrounding area. If radiation levels are too high to allow human operators to work in the vicinity, the obvious solution is to employ remotely-

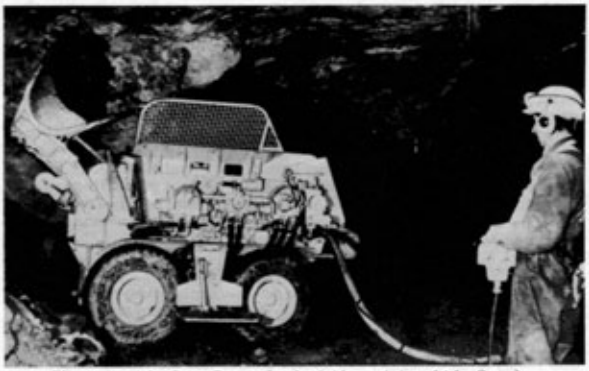

Photo 1. An Atlas Copco Remote Loader (*with permission of Atlas Copco*)

Remote Control of Earthmoving Equipment (1)

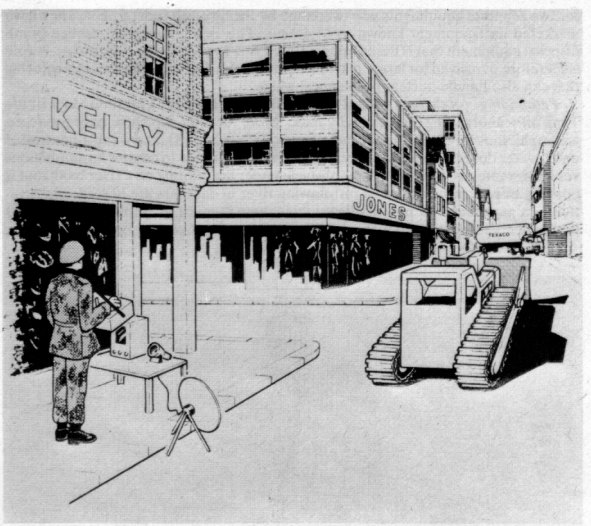

Photo 2. A Military Role for a Remote Control Bulldozer

controlled earth-moving equipment. Equally hazardous conditions could prevail where chemical or biological contaminants were the source of danger. Fire-fighting and relief operations in the wake of natural disasters are two further areas where remoted plant could be of value. Industrial fires may induce toxic fumes, chemical contamination or excessive temperatures that would prevent fire-fighters from entering the complex. The US Steel Company slag shovel has shown that a remoted machine can operate in such extreme conditions. A dozer carrying a hose, foam dispenser or rescue equipment could operate usefully and successfully in close proximity to a fire if suitably shielded and remotely controlled. Heavy machinery is inevitably required to remove rubble when earthquakes affect built-up areas. In such situations the rescuers are in constant danger from concealed crevices, further subsidence and buildings that are unstable. A remote operator could safely control rescue plant in districts that would otherwise be too dangerous to approach.

Explosive Ordnance Disposal. The British Army has proven the worth of mechanical assistance in dealing with terrorist devices. The cable-controlled Wheelbarrow was a first generation equipment that has been under constant development. New models will incorporate radio control. A successor has been designed, known as Marauder, which is a more complex, robust machine currently undergoing assessment at MVEE. The major disadvantage of Wheelbarrow was its limited mobility. For example, it was unable to deal with explosive devices in trains or in the cabs of petrol tankers, without assistance. The assistance came in the form of a remotely-controlled, rough-terrain, fork-lift truck that was able to lift Wheelbarrow to whatever height was required. (It needs little imagination to think of other useful applications for the cable-controlled fork-lift in counter insurgency duties). The need

Remote Control of Earthmoving Equipment (2)

for two separate equipments was overcome by the Swedish firm of FFV. They have marketed an equipment known as Minotaur. This is a remotely-controlled bomb disposal equipment that is based upon a Volvo BM Type 846 wheeled tractor. A role is therefore perceived for larger machines in this field. The Minotaur has attachments that can also handle nuclear or chemical waste.

Pathfinding. As early as 1968 it was possible to control the Chieftain Main Battle Tank on schnorkelling operations by radio. More recently, Komatsu have produced an amphibious bulldozer that is radio-controlled, (Photo 3), and a cable-controlled underwater dozer. The technology is thus readily available to control an amphibious vehicle remotely. Crossing a water obstacle under fire, exiting on a river bank that is possibly mined, or navigating a fast-flowing river in darkness are hazardous operations. In an attempt to minimise casualties there is merit in employing a crewless pathfinder vehicle to make the initial crossing. The Combat Engineer Tractor,

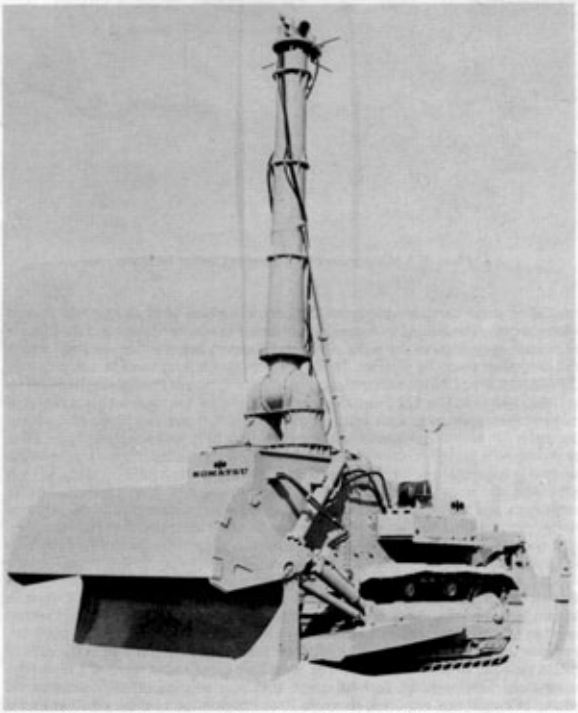

Photo 3. Komatsu's Radio-Controlled Amphibious Bulldozer (*with permission of Komatsu*)

Remote Control of Earthmoving Equipment (3)

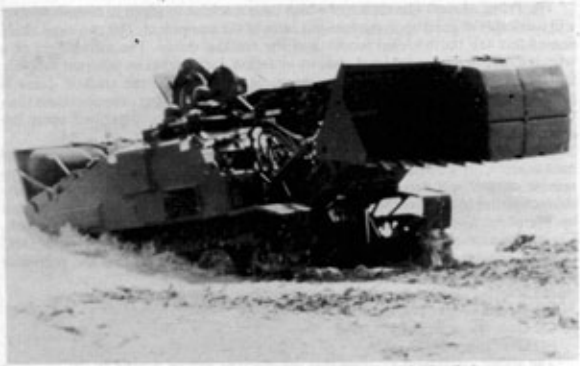

Photo 4. The Combat Engineer Tractor in a Pathfinding Role

(Photo 4), suggests itself as a most suitable vehicle for such adaptation, due to its excellent swimming ability and easy access to the hydraulic control spool valves.

Minefield Breaching. The breaching of a minefield by mechanical means is another dangerous activity that may be essential in war. Whatever device is employed, a powerful prime mover is required. An earthmoving equipment, controlled from a distance, has the following advantages over a tank as the prime mover:

(1) It is smaller and, therefore, a more difficult target for aimed, enemy fire.

(2) The survivability of an on-board crew has no effect on the mission success.

(3) It is cheaper.

(4) If destroyed or rendered immobile, it is less of a loss to the battle-winning capability of the unit than a gun tank.

The Axis armies used radio-controlled, mini-tanks filled with high explosive during World War II, to destroy strongpoints without casualties. There may be no similar use foreseeable with British forces in NATO, but it is an historical precedent that illustrates the value of remote control in battle and completes this brief review of some military applications.

THE SYSTEM CONCEPT

Now that a requirement has been seen to exist, it is necessary to consider what sort of remote control system may be needed. It is unrealistic to believe that an expensive piece of earthmoving equipment would be uniquely committed to remotely-controlled operations. This would reduce the inherent flexibility of plant to an unacceptable extent. An "add-on" system of modification for remote operation would be a suitable solution, allowing normal, manual operation in the majority of cases and permitting remote control when required. The modification should be simple and quick to effect, and be lightweight for easy transportation.

Although some applications in the military sphere can be undertaken with the operator close to the machine, most would be executed with the operator at some considerable distance from the task. This suggests that the control method should be some form of radio link. A cable link would also be more vulnerable to the physical dangers of the battlefield. To operate effectively at long range, a surveillance sub-system is required which permits the distant operator to view the ground and the task. The sub-systems, (Photo 5), which comprise the whole are outlined below:

The Prime Mover. The choice of which base machine to adapt to remote control will inevitably depend upon the forecast roles of the equipment. The two most likely contenders are the wheeled loader and the tracked dozer. The advantages of a wheeled machine in an internal security situation derive from its inherent mobility and the flexibility of its front-end equipment. Yet overall, the tracked dozer is probably the more versatile and can be used in a greater number of applications than the wheeled equipment. The following sub-systems will be described upon the assumption that they are to be fitted to a dozer.

But first, a little more needs to be said about the prime mover. The extent of modification, or amount of supplementary hardware, to convert the machine to remote control will depend upon the actions it is expected to perform and the characteristics of the machine itself. The plant with a remote control option offered by Marubeni-Komatsu is designed in such a way as to simplify the conversion. Current service equipment does not fall into this category. If the Caterpillar D6C medium crawler dozer is taken as an example, it will be seen that the following controls must be activated merely to make the machine move:

(1) Steering clutch left/right.
(2) Steering brake left/right.
(3) Gear select forward/reverse.
(4) Gear range 1/2/3.

The above assessment assumes that the machine will be started by the operator before the mission commences, that the decelerator will not be operated, that the hand throttle is pre-set and that no remote start facility is required. Equally, no mention has been made of the blade operation. Any design improvement that simplifies the manual operator's task (for example: a progressive steering control that includes both track braking and clutch disengagement) will simplify the installation of remote control. Perhaps this should become a consideration when machines are purchased in the future to replace current holdings.

The basic design of the Caterpillar D6C also limits the choice of actuators. An actuator is a device which responds to a command signal, causing the machine to

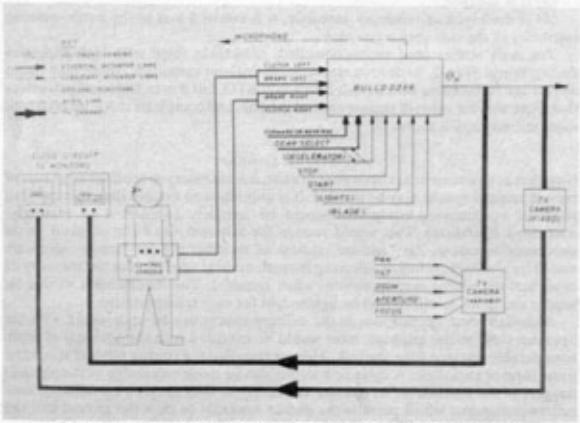

Photo 5. The Remote Control System for a Caterpillar D6C crawler tractor

react in a desired fashion. There are many different types of actuator but they all fall within the three broad categories of hydraulic, electrical or pneumatic. On a large earthmover, with existing hydraulic circuits, the natural choice of actuator would be hydraulic. A further important advantage of the hydraulic type is that they develop greater power, more smoothly, for a given weight and volume than other actuators. However, the hydraulic control spool valves for both gear changing and clutch steering on the D6C are situated well below the cab floor plates and are not easy to reach. In addition, the brakes are operated by a purely mechanical linkage with no hydraulic input. In order to meet the requirement for standardization of actuators on one machine, and to ensure that conversion to remote control can take place rapidly, the actuators must be electrical. Push-pull DC actuators can be operated successfully from the machine's batteries to act upon the levers and pedals that a manual operator would use. This is not the neatest engineering solution, but is a practical one arising out of the basic equipment design. A machine with completely hydraulic controls and readily accessible spool banks would be much easier to modify for remote operation.

Monitoring. For most tasks, the separation of controller and machine is unlikely to exceed one kilometre. To work successfully at this distance and at even shorter ranges in urban areas, the operator will require some form of visual monitor for both general movement and detailed task execution. An on-board microphone to relay audio information would also be of value. Such sounds would tell an experienced operator which gear range should be engaged, whether the machine was working effectively, or if the machine was under attack.

The ideal method of visual monitoring is close-circuit television (CCTV). There is some merit in having both forward and rearward facing cameras. The rear camera would be especially useful in towns or woods, where it may be necessary to reverse around corners or obstacles. However, this would require an extra camera and an extra monitor screeen which give rise to cost, bulk and weight penalties. The minimum number of cameras required for successful monitoring is two, both facing forward.

One camera should be fixed and give a general view of the area to the front of the machine. Preferably, part of the machine should be in the camera's field of view. This will act as a reference point for the operator and permit him to appreciate how the equipment is positioned relative to its environment. A second camera with variable pan, tilt and zoom is required for detailed work. These black-and-white cameras, their lenses and control motors are readily available on the civilian market at surprisingly little cost. Such cameras are small and easily armoured. In areas of radiation there is a risk that the lenses may darken, although this can be overcome by using special material lenses at a greater cost.

Experience has shown that subjects soon become proficient in manipulating tools or guiding vehicles remotely with CCTV assistance. Experiments with paired cameras providing stereovision have not yet shown an advantage over the simpler system of one screen for one camera. The monitor screen can be as small as 23cms and still provide excellent imagery. A disadvantage of the black-and-white picture is that the operator can find it difficult to estimate distance. To overcome this, improved perspective can be obtained by using a colour system, but, again, the cost is very much greater.

The Control Link. It has already been suggested that radio-control is preferable to cable-control in this particular application. The benefits arise from the risk of a cable being damaged or tangled and the separation of operator and machine that is envisaged. An outstanding disadvantage of the radio-link is the problem of ensuring that communications are maintained. This requirement is met by antenna alignment, frequency selection and output power.

A suitable carrier frequency would lie in the area of 200 MHz. This frequency range will permit operation in most weathers, at night, and in both urban and rural environments. A bandwidth of about 5·5 MHz would allow the use of a twin camera CCTV system and twenty function channels. Several forms of antenna would suffice,

but the simplest arrangement would be provided by a vertically polarized single dipole on the machine and a three element Yagi aerial at the console. A power output of 2 watts will permit operation at a range of 1 kilometre.

The above specification assumes that it will be an analogue link employing frequency modulation. A slightly more expensive and complicated digital system would provide considerable advantages if communications security were of primary importance.

The Operator Console. The console has a dual function of control and feedback monitoring, yet must remain small enough to be transportable in a land-rover type vehicle. A form that it could take would be similar to the design already employed to control the Westland Wisp remotely-piloted helicopter. This comprises a collapsible bench and stand which holds the operating panel and monitor screens. To simplify the operation of the dozer within easy viewing distance of the controller, there is merit in having a removable panel that could be slung from the operator's neck. Either system can be adequately powered from vehicle batteries.

For a simple requirement, such as track steering or gear changing, the switches on the panel can be the ON/OFF toggle type. The switches should be arranged in colour-coded groups, locating controls for similar functions in close proximity. The panel design should allow both hands to be used, with the most frequently employed controls in a central position. The detailed lay-out, spacing and number of switches will depend upon the functions ultimately to be controlled and the results of compatibility tests with potential operators. A great deal of assistance can be obtained in designing the control panel from research into ergonomics and from experience on existing control panels. However, perhaps the most valid lesson from past experience is that each console should be designed for its specific role and that the design must be subjected to user trial and approval before acceptance.

The Scope for Automation. So far, a rudimentary remote control system has been outlined for the Caterpillar D6C. It is for consideration that such a system may prove to be a heavy burden upon one man during continuous operation. Microprocessors have been used successfully in many other areas to simplify human involvement in a task and may, therefore, have a role in this application.

A specific area where the operator would benefit from automatic assistance is machine guidance. The controller must pay constant attention to the monitor screen when the dozer is mobile to avoid obstacles and choose the best route. It is possible to envisage an obstacle avoidance system that could be fitted to the dozer to reduce the controller's workload. The system would require a radar or ultrasonic sensing device that could return terrain information to an on-board microprocessor. The computer would interpret the existence of an obstacle, instruct the machine to change heading for a fixed distance and time, return to the original heading and check if the obstacle has been avoided. This simplified system could be improved to accommodate numerous changes and obstacles and still be capable of being programmed on a microprocessor.

There are, therefore occasions when some form of autonomy would be desirable on a remoted equipment. The choice will inevitably be between added complexity in the system and reduced workload for the operator. It is to be expected that minimal automatic assistance would be necessary for most of the roles envisaged for a service equipment. Nevertheless, the capability exists to provide automation on a remote-control machine and its possible employment should be considered from the very start of the design process.

Costs. Estimation of development costs is a notoriously difficult process. It is also true that the production of a small number of items tends to be disproportionately expensive, as economy generally arises from mass production. However, the requirement for only a limited number of remote control conversion kits for service plant is not expected to be a serious disadvantage due to the inherent simplicity of the basic system. The actuators, TV cameras, accessories and monitors plus the transmitters/receivers are available on the current market. Including the construction of the

operator's console, actuator brackets and camera mountings, the total hardware cost is less than £5000. Before a conversion kit could be accepted into service there are many hurdles to be overcome. A requirement has to be set, a practical design must be produced, the equipment is placed under trial and must be proven to be electromagnetically compatible with all other service equipment. At any of these stages extra expense could be incurred. It seems unlikely that such increased expenditure would double the cost quoted above. So, for several thousand pounds an otherwise manually-operated machine could be provided with a conversion kit permitting remote operation under hazardous conditions. This appears to be an acceptable outlay for the improved capability the machine will offer.

IN CONCLUSION

A possible, but not exhaustive, list of military applications for remoted machines has been given, along with the benefits of safety, comfort and efficiency that could be expected in more conventional earthmoving tasks. It is recognized that even these arguments may be insufficient to divert scarce defence money into providing remote control conversion kits for current equipments. Of course, there is a possibility that in the future a specific operational need may arise that could be successfully met by a remoted dozer or similar equipment. It is hoped that this article may have revealed the feasibility of remote control of a large machine by a relatively simple system that could be readily produced in an emergency. The proposed system is straightforward and utilizes proven components and known technology. It has been designed for simple installation and operation. Equally, it is a rugged and practical conversion that is suitable for use in the battle area.

The benefits of removing the soldier from the immediate vicinity of his equipment have been recognized in many applications. The Wheelbarrow and Marauder bomb disposal equipments have been mentioned previously. In addition, it should be noted that the Swingfire controller can be separated to the flank of his launcher, and that there is increasing interest in the use of remotely-piloted vehicles for surveillance and target acquisition. To meet the construction times demanded of the next generation bridging equipment there may be no alternative to adopting some form of automation or remotely-controlled mechanical handling. An item of earthmoving equipment under remote operation would not be unique on the battlefield as a result of its control mode. It would be unique in the range and type of tasks it could perform. Whether Sappers can afford to ignore this potential of remote control is a question that time alone will answer.

* * * *

PORTRAITS AND SILVER OF RE HQ MESS

PUBLISHED BY INSTITUTION OF ROYAL ENGINEERS PRICED £1.50

THIS beautifully illustrated book contains the photographs and descriptive details of fifteen Mess portraits and forty-one pieces of Mess silver. It is a fascinating reference book on the familiar items we have seen and on which our knowledge, (for most of us to say the least), is sketchy. Which portrait was the first to be acquired by the Mess? Which piece of silver is the most valuable? Who was Ko? Who was the first engineer officer to command a British army in the field! The answers to these questions and many others are yours for the asking price.

Engineering Their Way

MAJOR H E VIALOU CLARK RE, BSc, C Eng, MICE

Commissioned in 1960 the author took an Engineering degree at RMCS before joining the Gurkha Engineers for three operational tours in Brunei and Sarawak during the confrontation with Indonesia. A desk-bound job was followed by his appointment as 2IC 30 Fd Sqn in BAOR. In 1968 he was on his Long Civil Course (he was on "Spaghetti Junction" in Birmingham) followed by an RSME tour as an instructor in the, then, Civil Engineering School. In 1972 he became OC 522 STRE (Const) with world-wide commitments. His three years as OC 67 Gurkha Fd Sqn which followed were highlighted by an exercise in the Solomon Islands and liaison for and the construction of a Bailey Bridge from Hong Kong to mainland China. He is currently completing a tour as DCRE/PSA Area Officer, Nepal before taking up the appointment of CRE (Works) BAOR.

DCRE/PSA Area Office Nepal is not unused to receiving outlandish requests for help from the local population. Indeed many of them provide us with amusement when discussing the day's work over a jar of ale (at 75p a pint). All requests are considered and some are granted. This story tells of one such request which, on the face of it, was so bizarre as to warrant only the briefest investigation.

I was asked if we would build a sixteen mile stretch of road from Dharan Cantonment to a village which rejoices in the name of Mahendranagar. The first six miles would pass south through jungle and the remainder along the flat, silty *terai* which forms the Nepali part of the North Indian plains. Not wishing to appear unhelpful I agreed to have a look and after following a circuitous route by Land Rover we started at our destination—Mahendranagar. A long-disused narrow gauge railway line had been built to carry stones quarried from the Himalayan foothills to the site of a major irrigation scheme and this line was to be used as the alignment of the new road.

We were told the track was motorable so, engaging four wheel drive, we set off. After two miles we became bogged and having made futile efforts to break free we decided to wait until sufficient locals had gathered to witness our distress and then to recruit their help. The temperature was near 100°F and the humidity high. By the time we arrived home spattered with mud, dying of thirst and inevitably disillusioned I was not in the frame of mind to be greatly helpful. However, I did see their point!

"How much will it cost?"—"Oh, about £100,000"

"Will you build it?"—"No!"

I explained the project was well suited to receive Nepal Government aid, perhaps sponsored by the World Bank with an international team of consultants and contractors. It was the classic case of "don't ring me, I'll ring you".

I had hoped this unrealistic advice would have frightened them sufficiently to leave me alone. It was not to be! Six months later the project liaison officer, a most persuasive man called Harkabahadur Rai, beseeched me to accompany him that day down the alignment. With an empty "In-tray" it was difficult to convince him I was

Major H E Vialou Clark RE BSc C Eng MICE

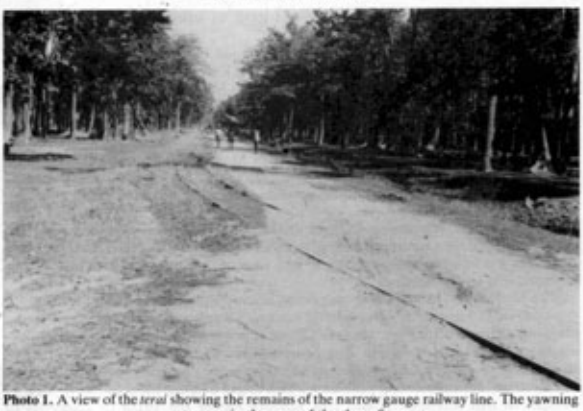

Photo 1. A view of the *terai* showing the remains of the narrow gauge railway line. The yawning crater was in the area of the three figures

too busy. Reluctantly I agreed to look at the road but only the nearby jungle stretch. Staff Sergeant Tom Wye, our Military Plant Foreman (MPF) was hurriedly called and we set off.

To my surprise I saw the overhanging trees had been removed on my earlier advice and the track had dried out reasonably well. This was the first and least of the surprises on that memorable day. On reaching the southern edge of the jungle I declared my intention to return to my In-tray. Harkabahadur became very agitated and called on God to make me change my mind. With Him on his side there was nothing to do but go on.

Imagine our astonishment when a mile further on we were met by 300 local people. S/Sgt Wye and I were garlanded and after a brief speech of welcome we were invited to inspect the road works. We paraded down four miles of previously unmotorable track which was now brought to level by thousands of cubic metres of uncompacted silt. Lining the route were hundreds of sweating Nepalese with shovels and baskets who stopped work to cheer, clap and *Namaste* before falling in behind to follow their newly titled "Chief Engineer Sahib".

This exercise in coercion, to which I had become an unwitting victim would take some beating! How could I possibly refuse to help now? The people had, by their own efforts, given voluntarily, done the best they could. They now needed compaction plant and imported gravel to give their efforts some chance of success. At last here was a major example of self-help which demanded assistance.

The procession continued until we reached a yawning crater some sixty feet wide and twenty feet deep.

"How can you help us here?" shouted the *Pradhan Panch* from the depths. This man is the equivalent of a town Mayor in UK. He was old and withered, had not a tooth in his head and wore heavy dark glasses. As I got to know him I became greatly impressed by his energy and leadership. It came as little surprise to hear he won the Military Medal for bravery fighting for us in Burma.

"I can't" I replied, "I have insufficient money or materials and I am not a magician". Nervous murmurs ran round the crowd and I realized the force of my argument had struck home.

"How much will it cost to build a bridge?" was the next question. This was not an

Engineering Their Way (1)

easy one but rather than lose credibility I gave an answer that suggested many thousands of rupees.

As we moved on to the end of the road the *Pradhan Panch* addressed the crowd which was now over a thousand strong. The "Chief Engineer Sahib" had promised to help (cheers, claps etc) and he concluded with an impressive oration for yet more stirring efforts. In true Nepali fashion I was then asked to say a few words. This was it—the Saviour was about to speak! The multitude became hushed as I mounted the Land Rover bonnet and spoke. This moment represented the high-point of my pomposity. I saw myself as the Mountbatten of Mahendranagar!

The weeks that followed were to remind me that many years of sitting in classrooms and gaining endless paper qualifications cannot replace hard practical experience gained on site.

DCRE plant and tippers spent three weeks bringing in river gravel and compacting the road and then returned to camp to await the onslaught of the monsoon. I was curious to see how the road stood up to it in view of the 150mm of rain in one hour recorded just to the North of us.

The ubiquitous Harkabahadur appeared and we set off for another inspection. I was encouraged to see the speedometer reading 40mph as we motored through the jungle stretch and on through the *terai*. Three culverts had been built and I waited to see the yawning crater. It had disappeared! They had filled it in—by hand! The natural flow of water had been diverted and, despite the unusually severe monsoon, I could see no real engineering problems which might damage the road. Why hadn't I thought of this solution? It had cost nothing except the sweat of hundreds of volunteers. What bad advice we Westerners can give if we do not fully understand the ways of the East!

All that now remained was the opening ceremony so a date was fixed. S/Sgt Wye and myself were invited to watch Senior Government Officials cut the tape. They didn't turn up! The *Pradhan Panch* officiated in their absence ably assisted by local notables and a priest. I was asked to place a garland around the photographs of HM The King and Queen of Nepal and in time my turn came again to say a few words. What could I say? The advice I had given was, in general, the text book solution. I had

Photo 2. The ubiquitous Harkabahadur with the DCRE and the MPF discussing a point of deep technical interest with the plant operator

supplies, temporary roads, temporary camp structures, and so on. My staff comprised eight Garrison Engineers, who, with the exception of one civilian, were all British Officers, and about twenty-five Clerks of Works, Mechanists and Clerks, all British Other Ranks. My direct labour force numbered some seven hundred Chinese and Tamil skilled, semi-skilled and coolie labour. All our work was carried out under very difficult conditions, as air raids were practically continuous and once the Japanese had brought their artillery up to the Johore Straits we were subjected to shelling. Needless to say this scared the labour force whose members began to dwindle. The "credit system" for the coolies had ceased; and this meant paying all the labour every day. As the labour force was split up into gangs working over half the Island, this was quite a big job in itself. Certain of the big building construction firms did splendid work for us right up to the end and their help was invaluable.

By about 10 or 11 February things had become so hot that practically the whole of the labour force had disappeared and certain of my staff had had to come back to my office, because, (a) they had no labour and, (b) our troops were falling back with the Japanese advancing across the Island. My installations, other than those in the Alexandra Depot in which my office was situated, were being smashed up either by bombing or shelling and useful work really was coming to an end. OC Troops of the Depot Area had commandeered my office block, with the exception of two rooms which served as office by day and sleeping quarters for myself and any of my staff who happened to be around, by night. This was my first taste of sleeping on concrete and although I had a mattress I didn't think much of it. Little did I know that I should be pleased to throw myself down on anything to get some sleep for about the next five weeks.

Away behind the office, on one of the Islands at the entrance to the harbour was a battery of, I believe, 9·2 howitzers and their shells were coming across making a most extraordinary "gobbling" noise, as they rushed through the air on their way to the north of the Island. This went on for a considerable time. I did not think there was so much ammunition in existence.

So up to 12 February the position was that we did whatever work we could to assist the troops, with continuous air raids, (the air raid sirens no longer worked as the planes came over in relays; but we had "spotters", which allowed us to work up to the last moment before rushing into a slit trench or ditch) and some shelling.

My story really begins on Friday 13 February 1942. OC Troops called me in and said that my unit was to man two positions on the perimeter of the Depot. Now I had tried to arm my men as they had been working in outlying places with the enemy not far away, but although there were plenty of revolvers hanging on the racks in the Depot these were not allowed to be issued. I reported this to OC Troops who soon remedied this trouble. My officers and men fell in and, figuratively speaking, were relieved of their measuring rods and handed revolvers or rifles and ammunition. Some had never fired a shot before in their lives, whilst others had fired a course perhaps a year or more ago. I was a little more lucky than most in that, as a member of the Singapore Volunteer Corps before joining up in 1939, I was a machine gunner and as such had used a revolver fairly frequently, but had only fired one course in the army. The positions we were to man covered a barrack block and the power station and officers and men were detailed off to their posts whilst I remained at the office with two Sappers. I would like to mention here that my one civilian GE was an elderly retired PWD Engineer, Mr Hutton, and he was simply broken hearted when I ordered him to leave the Depot, but it was impracticable to have a civilian around at this stage of the proceedings. Incidentally, Mr Hutton would each month hand over the whole of his pay to the War Fund saying that it was his little contribution as he was too old to fight, which I thought was a pretty good show. He was a grand chap and I most sincerely hope that he was not injured in the bombing and shelling that followed.

We had the usual air raids throughout the morning and in the afternoon the Japanese started shelling Brigade HQ which was on a hill just behind my office.

under-estimated the power of muscle and shovel which in this case had been carefully controlled by superb leadership. (I learned later that the *Pradhan Panch* had himself mounted guard on our machines during the nights!) I confined myself to a few congratulatory remarks and was followed by the *Pradhan Panch*. He started quietly, his voice rising slowly to a crescendo in the manner of the great orators. By the time he had finished he, and others, were clearly emotionally disturbed. The gist of his speech contained scathing attacks on officialdom, demands for continued efforts and blessings on the DCRE's children to the third and fourth generation!

So ended the first chapter of a story to which I feel sure other events and episodes will be added. As this goes to print Chapter Two is under discussion and I feel sure my successor will enjoy the experience of being involved in Chapter Three with so many Nepalese who are prepared, by hard manual labour, to help themselves.

Two Into One Does Go

MAJOR R A BRADBURY RE, BSc

The author was commissioned from Sandhurst in December 1963. As a Tp Comd he saw service in both Aden and Malaysia before being appointed 21C 54 (FARELF) Sp Sqn in 1970. He attended a degree course at RMCS, did a tour as an instructor at RSME, completed a Long Civils attachment in USA and attended Staff College. In April 1977 he assumed command of 2 Fd Sp Sqn in BAOR and recently took the Sqn to N Ireland in the infantry role.

If you were asked "which is the oldest squadron in the Corps?" it would seem rather natural to reply that it must be 1st Field Squadron. As with many things connected with military history, however, this apparently logical answer would be erroneous. Prior to its re-designation as a Specialist Team Royal Engineers, the oldest and most senior Squadron in the Royal Engineers was 1st *Fortress* Squadron. This Squadron traces its history back to the Corps of Soldier Artificers which was formed in Gibraltar by Royal Warrant on 6 March 1772. The Company, as it was called, gradually increased in strength until it was too large to be administered as one unit and in 1782 it was unofficially divided into two. It is from this date that the separate history of the Second Company begins although the official division of the unit did not come until 30 June 1786. The Second Company stayed on the rock until 1812 but during this period several detachments were furnished for service in various places. One such party went to Egypt in 1801 where they served with Sir Ralph Abercromby at the Battles of Aboukir and Alexandria and later with the mission to the Turkish Army. It was at Aboukir that they assisted in the capture of the oasis from which 2 Field Support Squadron takes the Palm Tree as its emblem.

In 1819 the Second Company was officially redesignated as 2nd Company Royal Sappers and Miners and in 1856 they became the 2nd Company Royal Engineers. Change came again in 1872 when they were re-organized as the 2nd Field Company Royal Engineers. This title remained for the next seventy-six years, until in 1948, it was re-designated as 2nd Field Squadron Royal Engineers. Re-roling was by no means over for the Squadron, however, because in 1965 it became 2 Armoured Engineer Squadron and, finally, in 1977 the Squadron was re-formed as 2 Field Support Squadron, Royal Engineers. The Squadron has a proud and unbroken history of nearly 200 years and has seen service in Gibraltar, the Baltic, the Crimea, South Africa, Sudan, France, Belgium, Egypt, Palestine, North Africa, Ceylon, India, Burma, Singapore, Germany and England!

Although 1st Field Squadron also has a proud history, it is nevertheless, a relative newcomer since its history only stems from the RE Division. This Division was formed in 1885 for service in the Egyptian War with the Corps of Mounted Infantry. Later it was made a permanent part of the Cavalry Division and re-named the Mounted Detachment RE. Later it was expanded and became *the* Field Troop and, when others were formed, the 1st Field Troop.

The ancestors of 2 Field Support Squadron had already celebrated their centenary by the time the RE Division had been formed. As the oldest remaining Squadron in the Corps, therefore, 2 Field Support Squadron is second to none since it holds the premier position—*hence two into one does go.*

Major R A Bradbury RE BSc

Escape from Singapore—Part I

MAJOR FRANCIS L ANGELL RE

Major Angell died a few years ago but this account of his adventure in escaping from Singapore was forwarded to us by his second wife, his first (referred to in the story) having died just after the war ended. Major Angell will be known to a number of Members as he was the senior partner of Langdon and Every, Chartered Quantity Surveyors, who were based in Singapore before and after WW2. This is one of the very few accounts of an escape that have been published in the RE Journal. *It is a story worth publishing as it deals with courage in adversity and exemplifies some of the finest qualities of the British Army. It will probably be published in four parts. We are grateful to Mrs Angell for giving us permission to publish. The photograph is of a pencil drawing of the author.*

FOREWORD

I HAVE often been tempted to write an account of my escape from Singapore in February 1942, as it may be of interest to my friends, but I have never managed to settle down to the task.

Now, in January 1945, I have decided to record the events from the notes I made at the time. My wife, who got away with our two children on 31 January 1942, has just sent me a copy of *Singapore to Freedom* by Oswald W Gilmour. Gilmour was Deputy Municipal Engineer in Singapore and got away the day before my departure. I cannot hope to produce anything like his record of events. My story is told in a very amateurish manner. To those of you who have read *Singapore to Freedom* I would say that there are one or two points in my narrative which do not agree with Gilmour's, for instance, the date of the sinking of the *Shu Kwang*. Little things like this are bound to occur, as one's escape journey was a long succession of rumours, but I think all will agree that no matter how hard one tries to be accurate, little errors are bound to creep in.

Having read Gilmour's story, I was fired with enthusiasm to put mine on paper, and so, in January 1945, sitting on the verandah of my inspection bungalow in Sibi, Baluchistan, I am making a start. I only hope that I manage to keep it up, and that it will prove of interest.

F L Angell
Major RE

Sibi, Baluchistan

CHAPTER ONE

Perhaps it would be as well, before recording events of my actual journey from Singapore, to tell of the state of affairs as I knew them just prior to my departure on 14 February 1942.

I was, and still am for that matter, an Emergency Commissioned Officer in the Corps of Royal Engineers, and at that time was DCRE (Deputy Commander Royal Engineers) for the Western half of Singapore Island. My job was construction in all its varied forms, and for a week or so before the surrender all that was being done was to assist the fighting forces in whatever way possible; eg temporary water

Major Francis L Angell RE.

Fortunately or unfortunately, whichever way you look at it, the shells were all falling short and dropping alongside the office. This was most unpleasant, but the only damage was a few trees set on fire.

Early in the evening OC Troops sent for me and said that I was to assist him. He sat at a large table and on his right were about nine field telephones, one for each position on the perimeter, and one for Brigade HQ. My job was, apart from putting through dozens of calls about different things, to receive a call from each position every hour, or, failing a call, to send out a runner to find out what was the matter. I shall never forget this job. OC Troops had been wounded whilst serving with his regiment up country and here he sat with one leg completely encased in plaster propped up on a box. He was a regular officer and I should say a very fine soldier. He barked out his instructions (though this had nothing to do with his being a good soldier) which had to be obeyed at the double and he didn't turn a hair at any incident however unpleasant.

It was at this time that the Jap started some really serious shelling. Immediately outside the OC's room on the verandah was a sentry posted behind a 5ft sand bag wall. I remember looking up at the Colonel and seeing him glowering at the sentry, and, looking out through the window, I noticed that as the shells whined over the sentry flinched and when one dropped a bit too near, he ducked. I could see that the Colonel was getting very annoyed and at last he could stand it no longer. "Sentry" he barked, "The one that's going to get you, you won't hear coming so bloody well stand up, you are supposed to be a soldier." I felt damned sorry for that sentry because having shells dropping around the place is not particularly pleasant, but being stuck outside the building and having nothing much to do except calculate just how near the last one dropped must have been the bottom! I must confess that if I hadn't had my little job to do, I should have gone to ground, but with the Colonel behaving as though nothing whatever was happening all I could do was to pretend to be really brave. The whole affair seemed quite unreal because through the open door you could see military clerks typing messages and sending and receiving runners as though it was all part of a normal day's work.

The messages that came through and which I reported to the Colonel were most alarming and I should have thought were calculated to give any Commander the jitters, but he seemed to accept everything without batting an eyelid. I should very much like to be able to set down some of the messages we received if only to show the unfortunate things that were happening, but I'm afraid they would cause, what I believe is known as, an "International incident".

Then I couldn't get through to Brigade HQ. "I'm going to find out what the hell's going on" rasped the Colonel. "Is that wise Sir?" I asked. "Of course it's wise" he snorted, and with that hobbled off with his one leg and two sticks to his car. Brigade HQ was, as I have said, on a hilltop behind the office but to get there by car was a good three miles on a road which looped round in the direction of the enemy, who by this time were only about two and a half miles away. What with the shells dropping around the place plus the fact that the Jap was so near, I did not expect to see the Colonel again. However, in due course he hobbled back into the office and barked "They've cleared off". Just that—no more, but it must have meant a devil of a lot to him.

The defence of the area consisted of sections of Ordnance personnel in positions well outside the perimeter fence of the Depot. Word had come through that the main body of troops was withdrawing onto the Depot and my next job was not pleasant. I had to telephone the sections and give instructions for each one to send out a guide to lead the troops back onto the perimeter positions. This of course meant that the situation was by now far from satisfactory, if you could have called them satisfactory before, and I thought to myself "well my lad, you've had it" and for the first time I wondered whether I would be a prisoner of war or whether I'd "stop mine" before the end.

I really hadn't thought about it before, mainly I suppose, because I hadn't had the time.

And then something happened which completely altered everything for me. One of my own runners came in and asked me to take an urgent call from HQ, Fort Canning. I ran into my office and found it was my CRE, Lieut Colonel W H Treays RE on the 'phone. He said "Take this instruction, Major Angell will report to me at Clifford's Pier immediately with the following . . . (here followed the names of one officer and ten other ranks) and each will bring one kit bag." To this day I am sincerely thankful that my runner wrote down the instruction as I repeated it because, as events turned out, I was afraid that my officers and men might have thought I had "run out" on them. As it was he could vouch for my instructions. I sent both my runners to the Sapper positions to collect the men and reported my orders to OC Troops. He merely remarked "Before leaving give the necessary instructions to smash up the cold storage plant in the Depot." And with that the duties of OIC Supply Depot devolved on me. The cold storage held six hundred tons of meat so it was quite a fair sized job.

I threw a few things into my kit bag and awaited the men and my Second in Command, for whom I had sent. I gave the latter the necessary instructions about the cold storage, and the keys of my safe, which was full of dollars. Had I known then what I know now, I would have filled my kit bag with dollars . . . . but one only learns by experience. One of my runners wished me good luck on my journey and I did not realize what he had said until some time later because quite frankly, I imagined we had a job of work to do in the city and I did not for one moment imagine that we were to leave the Island.

I found two cars in addition to my own and sent off each car at a few minutes interval as the roads were being shelled and I hoped in this way that some of us would get through. From the time of receiving my instructions to the departure of the first car thirty-five minutes had elapsed. I hoped that I hadn't wasted too much time in handing over, but I need not have worried; there were to be many hours of wasted time.

That ride was a nightmare. We were only four to a car, but being trussed up in equipment, with gas masks, revolver, tin hat and kit bag, we just couldn't move. I started off by nearly wrecking the car. I was driving as fast as I could without lights when I suddenly found myself on the edge of a shell hole. Fortunately I stopped just in time and managed to reverse and find a way round. Those of you who know Singapore will remember that there is a fine, wide concrete road called the Tiong Bahru Road running from the Alexandra Depot to the docks. Before leaving I gave instructions to my men not to use this road but to take the more circuitous route through the town by way of River Valley Road.

If my information is correct it was a lucky decision as I was subsequently informed that the Japanese had filtered round onto the Tiong Bahru Road and we should all have been in the bag. Twice we were nearly shot up by our own sentries who challenged us, but what with being inside the car and the general racket going on it was quite impossible to hear voices.

I am happy to say that all three cars got through and on arrival at Collyer Quay (on which is situated Clifford's Pier) I was surprised to find many parked cars. I left my car with the others . . . it was my own property . . . and locked the doors and set off to find my CRE. It must have been midnight by this time and it was no easy matter to find any particular officer in the dark, or rather, in the peculiar light given by the many fires which were blazing in the vicinity, but I eventually tracked him down. There were many squads of men standing about but all seemed to be there for a purpose, and it still didn't dawn on me that we were to get out. When I reported to my CRE I found him with several Sapper Officers and a party of British soldiers. The men were immediately put in my charge and with my own chaps totalled nineteen. My party was apparently the last due to report, as the CRE then called his officers together and told us that we were bound for Batavia as there was urgent work to be done in Java. I can only say that I was astonished but may add that, without "shooting a line", I immediately thought of my officers and men who were left behind. . . . I

hadn't even wished them good luck. You see we had worked pretty hard together for a long time under rather trying conditions and there is something, which I can't explain, which grows up between men who pull well together and share a common danger. Frankly I was very upset . . . perhaps I'm just a fool. However I was under orders for Batavia and there was nothing I could do about it.

The groups of men had been marched off at intervals and I think the Sappers were the last. A guide was provided and we made for a back entrance to the docks which is literally miles from the docks proper. Here we struck a most unfortunate incident. This particular entrance consists of a high metal fence with a pair of gates in the centre and around these gates was a mob of hooligans trying to get through them. They were presumably supposed to be soldiers as they were wearing what was left of their khaki uniform. Fortunately they had no arms. Inside the fence there were Military Police armed with Tommy guns and on seeing us they opened the gates a little and passed us through with no little difficulty whilst the mob hurled abuse at us. Our guide took us through the dock area for a considerable distance past blazing godowns and over shell and bomb cratered roads until we came to Telok Ayer Basin. Here we caught up with the party which had been a little ahead of us and who were now embarking in a small launch. I mention this because I can only assume that to fill the launch the officer in charge must have taken three of my sergeants for, on calling the roll a little later, these three men were missing and were never seen again. (As late as 1944 the War Office asked me whether I could throw any light on what had happened to them. It may appear very careless on my part to have lost three men in this way, but it must be remembered that it was dark and that the two groups of men had joined up and the embarkation was controlled by an officer who would only be interested in filling his launch. Directly I missed the men, on embarking in a little ship lying out in the stream, I tried to check up on this launch, but if it reached our ship my men were not amongst those on board it.)

Another launch came along and carried us off into the stream to a small coastal vessel called the *Shu Kwang*.

CHAPTER TWO

The *Shu Kwang* was a very small coastal tanker and the fact that she was a tanker stood us in very good stead later. On embarking we found the very small deck covered with troops and we had to take what little space was left. There were, I believe, two hundred of us, comprising Sapper, Gunner, Signals, Medical and Australian Ordnance details. The ship had one gun mounted aft. In case we met any trouble we could console ourselves with the knowledge that there were two life boats and a few life belts; the skipper was a stranger to the craft and had a scratch crew. This all seemed very promising for a voyage through the Rhio Straits to Batavia on a route patrolled by enemy planes! However I'm afraid I'm one of those people who accept what comes and it didn't occur to me to curse the authorities for putting us on this cockle-shell of a boat to make this rather dangerous journey. On the contrary I rather took the view that this was a chance to save myself from becoming a prisoner of war as I was now fairly certain that Singapore had not a hope, although I didn't think the capitulation would come so soon; I realized however that if we got through without any trouble it would be a miracle.

After what seemed an age we got under way and within a few minutes were in the harbour off Clifford's Pier. Here much to everyone's surprise, we dropped anchor and then found that we had gone straight into one of our own minefields. This was indeed a magnificent beginning to a very eventful journey. The skipper said that he dared not move until dawn so instead of being well out by daybreak, we were sitting, a pretty target, within a few hundred yards of Collyer Quay or Clifford's Pier. Well, we tried to make ourselves comfortable but there was no question of sleep. I think each of us had a lot to think about. Sitting there on the deck, what little of Singapore that could be seen was not a pretty sight. To the left the docks were ablaze. Overhead was a great blanket of smoke showing angry red patches wherever fires were

reflected—and there were many such fires. In this peculiar light the buildings of Collyer Quay could be seen with Clifford's Pier jutting out into the sea.

I wondered what had happened about smashing up the cold storage, and what had happened to the two and a half million gallons of petrol that had been brought across from Pulan Bukum in forty gallon drums and dumped in the rubber off Bukit Timah Road. I had bulldozed great ditches around each dump to prevent lighted petrol from flowing down the anti-malarial canal into the city. I sincerely hope that they served their purpose. And what had happened to the magazines at Alexandra which were full of heavy shells? I hope they were destroyed. All the time new angry red patches would appear in the sky as some fresh fire started. Was it scorched earth or had the Japanese scored another hit?

Alongside me was a poor wretched lad—a Sapper—who that afternoon had taken his wife and baby down to the docks to put them on an escape vessel. On arrival there was a heavy raid in the dock area and he was instructed to take them back to a particular building in the town. After a while his time was up and he had to return to duty leaving his family to get back to the docks as soon as possible. He little thought he would be ordered out himself in a few hours. Poor lad, he didn't know whether his wife was still in Singapore or whether she had left. Later when we crossed Sumatra and went down into Java he inquired at every place where refugees had touched but found no trace of them. He was a brave lad.

My wife and two very young children had left fourteen days before and I wondered whether they had got safely away. I left them with no accommodation on the ship and learned subsequently that the two suitcases my wife was allowed to bring out had to form one "wall" of her accommodation, the other being furnished by the next woman and so on. Thank God my wife filled one suitcase with baby food for my ten months old son, as several babies were lost through incorrect feeding. The ship on which they had left received a hit whilst lying in the Singapore Docks and therefore had to crawl to Batavia owing to the damage. The ship was bombed throughout the journey and during the three days and nights she was under repair in Batavia but didn't receive a single direct hit. The terrible part was that the ship was completely blacked out, that is, no lights were allowed during raids and the one thousand women and children were shut up in the dining saloon and lounge. You can imagine the women sitting there in the darkness with all the children crying with fright at the racket going on outside. My wife during these raids had the baby on one arm, a small bag with baby food and a few warm clothes for him in case they had to take to the boats, three life jackets and Bridget aged three years, hanging onto her skirt. It must have been a nerve racking experience for those mothers. Yes, we all had quite a lot to think about.

But our thoughts, probably fortunately, were rudely shattered. The Japs started shelling Collyer Quay and as we were lying so close, shells were dropping in the water around us. Each of course seemed as though it was directed at us. We saw the cars go up in flames and I remember how pleased I was that some grinning little Jap would not be seen riding around in my car. This excitement lasted some time and I thought dawn would never arrive.

I am a little confused as to the time we actually got under way. My note book distinctly says that we left at dawn and yet I remember passing a large troopship beached on a small island and blazing furiously in the dark. However I expect my notebook is correct and that we passed the trooper in the grey light of dawn. We steamed slowly out of the mine fields without mishap but it was a most uncomfortable experience. I think each and every man was holding himself pretty taut awaiting a colossal explosion and the feeling of relief on being given the all clear was tremendous.

My Sappers volunteered for engine room duties and any odd jobs that needed attention. The Gunners examined the gun and hoped to put up some sort of show if the Japs came over. If I remember correctly it wasn't an Ack-Ack gun and had very little elevation. The RAMC cheerfully pointed out that they had no instruments or

bandages in case of trouble and that they would have to rely on each man's field dressing. The senior officer on board had by this time more or less established himself as OC Troops and things were getting fairly ship shape.

I remember the morning passing most peacefully, brilliant hot sunshine with a blue sea which, after the racket of the bombing and shelling of Singapore, was most restful. We were of course on or near the Equator.

And then someone shouted "Here they come" and looking into the sun one could see nine planes approaching. There were of course the usual shouts of "They're ours", but I'm fairly certain that nobody on that ship could tell a friendly plane from a Jap! Anyway I think the shouts of "They're ours" put the Gunners off their stroke as they only got one shell away which did no damage, and then hell was let loose. Most of the men were sitting amid ships and were very tightly packed. I was on the small upper deck at the rear of the ship with a Sapper major friend of mine. The planes came in very low and all released their bombs together. For a fraction of a second I watched the "eggs" coming for us and then fell flat on my face next to my friend. Although it could only have lasted for a second or two, I can still remember the extraordinary swishing noise as the bombs rained down on us. There was a deafening noise and then all was quiet except for the hum of the planes as they flew off. Not a single direct hit! All the bombs had fallen in the water along our starboard side but the effect of the blast and splinters was appalling. I got up, but my friend did not move, I imagine he had stopped a splinter and he died within a very short time. Poor chap, we were lying side by side, he got his and I got off scot-free. On going down to the main deck I found the place in a shambles. Without going into details I may say that bits and pieces of human bodies were all over the place, the deck was slippery with blood and filth and the smell was awful. I now realized that I was walking like a "drunk" and couldn't keep a straight course and imagine it must have been the effects of blast.

All the men manning the gun were blown to pieces. The RAMC shouted for field dressings and got down to their grim business. One poor chap came to me holding his right fore arm with his left hand and said "What do I do with this?" I took his right hand, and both hand and arm came away from his body. I threw it over the side and he dropped dead.

I located all my men and found some of them either wounded or burned but none seriously. Those working in the engine room received scalds from burst pipes. Two of our office were wounded. The blast had put the engines out of action and now we drifted on the open sea. We set about straightening things up. We gave the lads a sea burial which was a very grim business indeed as one could only collect the pieces and stitch them up in tarpaulins; we then cleaned down the decks. However the stench remained. Whether it really remained on the ship or had got into ones nostrils and remained I cannot say, but it made you feel sick. I must say that the RAMC worked like niggers and did their very best with nothing but field dressings. I would like to mention the name of Major Rogan RAMC as deserving particular credit. The ship's crew were completely useless in that they wouldn't even try to get the engines going again, so down went the Sappers to try and effect repairs. They didn't succeed, but it wasn't for lack of trying and they were still trying when the next dose arrived.

The raid I have described took place at 1.15pm and we drifted along until about 4.00pm when four more planes appeared. This time there were no shouts of "They're ours". Frankly I had the wind up. I did not think that this time we could possibly avoid a direct hit as the ship was out of control. It so happened that I was on the bridge trying to get away from the stench. Again the planes came in very low and again they released all their bombs together. Once more I fell flat on my face on the steel deck of the bridge and once more came that awful swishing noise followed by violent explosions and then a most amazing thing happened. My body actually bounced up and down on the decking three times. It may sound ridiculous but I know I said "What the hell". I was so thunderstruck that I hardly realized I was almost winded. And then a deluge of water poured off the bridge roof. Apparently all the

bombs had dropped into the sea alongside the ship, which had caused her to rise very high in the water and then down she came with an awful crash, sending water right over the bridge. You can take it from me that to bounce up and down on your tummy on a steel deck is the most amazing experience and you really wonder what the devil's going on. Well, I ran down to the deck and, thank God, on this occasion there were no casualties. But the little ship gave a nasty jolt followed almost immediately by another. Now after the first raid it was found that several bomb splinters had gone through both our life boats and the Sappers had patched them up as best they could with odd pieces of wood. The crew now proceeded to lower these life boats and they soon had them completely tangled up with one end high-and-dry and the other end submerged in the ocean. When this was straightened out they leapt into them and this started a panic. Men started jumping over the side into the water with any odd piece of wood or furniture that would float. I yelled to my own men to stand fast, which thank goodness they did, and I told them stay put.

We got the crew out of the life boats and succeeded in getting some of the more seriously wounded into them, but bailing was necessary right from the start. And now some soldiers took it into their heads to behave in a most extraordinary fashion. They whipped out their bayonets and slashed open all the kit bags within reach, filled their pockets with anything they fancied, and then jumped overboard. I have often thought about this and I still cannot understand the mentality of a man who loots other people's belongings before leaping into the open sea from a sinking ship. I can only assume that they must have been the dregs of some slum. I would dearly have loved to plug a few of them. All the Sappers were still standing together and all the Sapper officers were present. I have never seen a more disgraceful exhibition of panic in my life. I had always thought that the British were supposed to remain calm under such conditions—I'm afraid I was thoroughly disgusted. Please don't for one moment think I'm suggesting I wasn't frightened—I was scared stiff, but I am sure you will agree that there is a vast difference between being frightened and losing one's head. I would like to say that the skipper did not give the order to abandon ship. We now sat in a bunch on the deck with the few others who had not gone over the side together with the skipper. We smoked endless cigarettes and watched the other poor devils disappearing into the ocean. This is where we thanked our lucky stars that our little ship was a tanker. She was settling down in the water but her tanks were keeping her afloat longer than would otherwise have been the case. The bombing had opened the plates of the ship but seemingly had not damaged the tanks. This explanation may be quite wrong but that was the conclusion we came to. We collected a few things which would float against the time when we might have to jump for it, and having nothing else to do, settled down to chain smoking. Never have I appreciated cigarettes as I did during the next couple of hours. There is no need to tell you what we were all thinking. A small ship steadily settling down in the open sea, no land in sight, aware of having drifted for three hours so that most probably we were off any course set by any other escape ships, if there were any, and that it would be dark by 6.30pm. It wasn't pleasant.

Then a miracle happened. A little smoke on the horizon. Was it coming our way? These were awful moments. But come our way it did and finally we could discern three little vessels. One was a small armed motor launch, another the small freighter *Tengorah*, and the third was the little armed auxiliary, the *Tanjong Pinang*. The skipper of the *Tanjong Pinang* hailed us, although needless to say we had cheered like hell, and said he would look around for survivors and then return for us. Naturally this was the thing to do but I was very scared least he return a little too late.

But there was no need to worry, he got back alright with a few survivors and came alongside. He said he would take everybody but would not take anything in the way of equipment or baggage. As it happened I was most fortunately wearing trousers and a shirt when I left Singapore (shorts would have been terrible on the journey that followed,) so in this rig plus belt, revolver, and tin hat I boarded the *Tanjong Pinang*. One other thing that I managed to do was to grab my respirator case, throw the gas

mask into the sea and keep the haversack portion which later proved very useful. I was very happy that the Sappers had stuck together and here we were, without having had a ducking, making another bid to reach . . . where? I suddenly realized that possibly we could not make Batavia.

It was now getting dusk and, irony or ironies, we fired four rounds into the *Shu Kwang* to hurry her to the bottom.

The *Tanjong Pinang* was a very small ship and we were stowed away in, what I would call, a microscopic kitchen. Here the few survivors stripped and dried their clothes by the fire and we all had tea to cheer us up. It was quite impossible to move in this tiny room but we were soon turned out as the crew wanted a meal and they couldn't come in until we got out!

It was by this time quite dark and there wasn't a single light in the ship and we were guided through into what I found afterwards to be the hold. Directly the door was opened something hit you. It was the same ghastly smell as on the *Shu Kwang*. We groped our way in and the door was shut. The place was literally full of bodies, all wounded and smelling to high Heaven, and you couldn't see them. A Colonel and I found a space to sit, a box or something similar and chatted a little. In spite of the stench I suddenly realized that I was damned hungry. I had not had any food since breakfast on the previous day. Fortunately, in a short time, a sailor came in (I assume he was a sailor as he could not be seen in the pitch darkness) and said "Here you are mates, some stew", and handed plates of really hot stew to anyone who could find him. I grabbed one for myself and one for the Colonel and we got down to it. There were no utensils so you held the plate under your chin and ate with your fingers: what didn't go into your mouth either slid back into the plate or down your shirt; but it was very, very good. I was terribly pleased when the Colonel said "Frank, this stench is getting me down, I'm going to explore and try to find some fresh air, if I'm lucky I'll come back for you." After what seemed an age he groped his way back and said he had found his way out and that the skipper had said that, providing there were only two of us, we could sleep on the gun platform. The Colonel warned me to be very careful where I put my feet as the floor was covered with wounded. We crawled along feeling for bodies, carefully stepping over them, and eventually found our way up to a gun platform. There was a light Ack-Ack gun on a circular iron platform on each side of the little bridge which was well for'ard. Here we sat and chatted and watched the officers on the bridge which was slightly below our level. It was a lovely night fortunately, although a little chilly, and the little ship was making steady progress through a perfectly calm sea. I soon felt that I had had enough for one day and lay down on the steel platform to get some sleep. No doubt you will laugh at me but I have decided that for sleeping, concrete is harder than wood and steel is a damned sight harder than concrete. This platform was bloody hard.

At 7.50 am on the following morning, 15 February, I was awakened by being kicked off the gun platform. There they were, nine Japanese planes circling overhead. The hatches had been taken off the hold and the wounded were lying in rows on the floor. I was sent down to join them and found Captain Beadnall RAMC and his colleagues tending the wounded and keeping them quiet. Owing to the planes overhead some of the men tried to get up but the MO's held their hands and did everything to soothe them and there was no fuss. I greatly admired these doctors, they didn't turn a hair and never once looked up at the planes which must have taken some courage. One of the Naval Officers reassured us by saying that unless we got a direct hit we were perfectly safe as the sides of the ship had been specially strengthened to withstand blast and splinters. The guns were manned but there was no firing and the Japs, after circling round for some time pushed off without dropping any bombs. I don't know whether I was getting jittery but I didn't like that visit much. I wondered whether another flight would come out and not be content merely to look at us.

We kept on a steady course all day and there were no further incidents. I felt very happy that I was in the hands of the Navy. Everything on board seemed to work like

clockwork and gave one a sense of safety. We learned that we were heading for the Indragirrie River in Sumatra and that we could trek across the Island to a place called Padang on the west coast from which, with luck, we would get a ship of some sort to carry us on. It seemed that the *Tanjong Pinang* was evacuating wounded and escapees from Singapore who had been sunk, but who had managed to get on to the dozens of small islands in the Rhio Straits. The officers and crew were doing a grand job but Gilmour in *Singapore to Freedom* says "The *Tanjong Pinang* has not been heard of since February 16th. But the latest news seemed to indicate that the little ship was captured by the Japanese somewhere in the Java Sea." I sincerely hope that the skipper and crew are safe, they were a grand lot.

We made the Indragirrie River on the afternoon of 15 February, the day that Singapore fell (although we had no knowledge of this,) and steamed slowly up the river through thick jungle to the village of Tembilahan at which we arrived at 4.30 p.m. It had been a fairly exciting two days but so far, apart from my friend the major, our party was alive, although nine were wounded. We said good-bye to the *Tanjong Pinang* which shortly after sailed off back to do more good work.

(To be continued)

Correspondence

Brigadier J R E Hamilton-Baillie MC, MA, C Eng, MICE
Rectory House
Stanford-in-the-Vale
Faringdon
Oxfordshire

THE NEW ARMOURED DIVISIONAL ENGINEERS

Sir,—I read the article in the September 1978 *RE Journal* on "The New Armoured Divisional Engineers" with interest. I am not competent to comment on the suitability of the new establishment to support the new Divisional organization. I must admit I do not find the pattern of three Field Squadrons, a Field Support Squadron and a Regimental Workshop in a Regiment under an HQ RE very revolutionary. When I commanded a Squadron (1953–56) in 23 Field Engineer Regiment who were the Divisional Engineer Regiment of 2nd Infantry Division, the organization was three Field Squadrons, a Field Park Squadron and a Light Aid Detachment (LAD). There was a War Establishment only, for an HQ RE at Divisional Headquarters, though this was later implemented to the extent of one officer (me, as GSO2 RE).

What rather startles me is the surprise that is shown at the delegation of responsibility to Squadron Commanders. At the time of which I speak the Regiment was a new idea, its HQ replacing the old HQ RE. We were only about the second generation of Squadron Commanders who had not held independent command during the long history of the Corps. We all rather resented this and held on jealously to our independence as far as we could. We held most of the "new" responsibilities that are mentioned by Lieut Colonel Willmott. Of course we planned the individual training of our men, and Troop and Squadron exercises. Of course we were responsible for the state of our MT, plant and equipment. We would certainly have expected to go to the Field Park Squadron for our support needs.

It seems things have slipped badly in the days of small regiments and too many tiers of command, all having to justify themselves. For some one hundred and fifty years the Corps prided itself that young Majors and Captains held independent command with confidence and success. The closer we can get back to those days the better.—Yours sincerely, J R E Hamilton-Baillie

Engineering Services Directorate
The Crown Agents for Oversea Governments
and Administrations
4 Millbank
Westminster SW1P 3JD

ROADS IN BELIZE

Sir,—We enjoyed reading Mr Griffiths' article ("A Bridge Too Much?") about his experiences in Belize, but we question his description of driving on roads there—"much akin to a Cresta Run descent in a 40-gallon drum".

Our recollections of the Cresta Run are mortal terror, fearsome noise, and frequent strictures by the maintenance team of our excessive use of the brake (an ineffective device screwed into the toes of our boots) which scrapes the running surface. After our mid-morning attempts the run was closed for the day, and water applied to parts of the surface to provide a smooth, icy track for the *Bibbias* the following morning. The *u-value* of the track first thing must have been less than 100—equivalent to a motorway surface in this country.

Our Management Teams have been busy reconstructing roads in Belize for some years (notably the Western Highway and the Northern Highway north of Orange Walk). If Mr Griffiths intended praise in his description of driving on the Western Highway, of course we are delighted. But the bit about the 40-gallon drum is a little disturbing!—Your *Burmese* friends, *U-No-Hu*

Colonel R Jukes-Hughes MBE, C Eng, FICE, MIHE
HQ 2 Armd Div
BFPO 22

AIRFIELD ENGINEERS

Sir,—Royal Engineer units employed on forward airfields construction made a major contribution to the success of air operations in every theatre during World War 2, most notably during the advance through Burma where they were frequently right up with the forward troops.

Their story has never, to my knowledge, been told although it must surely be a fascinating one. I wonder if any ex-Airfield Engineer officers would be prepared to write in the Journal of their experiences.—Yours faithfully, R Jukes-Hughes

Colonel I T C Wilson MBE, MC
Bryony Cottage
Stockbridge Road
Kings Somborne
Hants

WHO WILL BE THE LAST?

Sir,—The opening paragraph of Major Phillip's article on the Irrawaddy Crossing Painting led me to wonder if this year would be the last in which the Corps would still have serving members who actually saw active service in the Second World War. From the RE List it appears that General Sir Hugh Beach may be the only such General Officer, and there are not many left in the more Junior ranks. Having landed in Normandy on 6 June 1945 as a teenage platoon commander, I can claim to be one of the few remaining, until July! It would be interesting to know who will be the last.—Yours faithfully, I T C Wilson.

Memoirs

BRIGADIER J G CARR CBE BA

Born 1 September 1911, died 12 July 1978, aged 66

JAMES GOUINLOCK CARR was born in Montreal and was educated at Upper Canada College and the Royal Military College, Kingston. Whilst at Kingston he distinguished himself, firstly, by becoming Senior Under Officer, receiving the Sword of Honour and the Governor General's Silver Medal, and secondly by playing on both the Canadian Football and Ice Hockey 1st teams for all of his four years and captaining both in his senior year. He was also an excellent pistol shot.

Many members will remember the scar on his chin. In the final of the Canadian Intermediate Hockey League he had taken the puck the length of the ice when he was body-checked by three opponents with sacrificial violence and his chin was cut to the bone by a skate. No time for stitches—two metal bulldog clips and adhesive tape from ear to ear and he was back on the ice inside four minutes. RMC won!

In June 1932, on graduation from RMC, he was commissioned into the Royal Engineers and after a brief tour at Chatham went up to Cambridge graduating in 1935 with an Honours degree. In these early thirties he continued to make a name for himself both academically and in the field of sport. On one occasion, having played for Cambridge against Oxford at Lacrosse in the afternoon he drove his Baby Austin to Wembley to take the ice at 7.30pm as Captain of the British Team in an International match. During this period he also played ice hockey for the Wembley Lions.

In 1936 he served in Egypt and Palestine and in WW2 he was with the BEF in France, Belgium and Norway. Later he tackled all those jobs that came his way—be it in units or on the Staff—with wise humour and distinction. He commanded a Squadron in 7 Armoured Division and was a most considerate and fatherly figure to his young troop officers who needed all the confidence they could muster. In the early days of the war, when he was a Commando Instructor in explosives, he swam the Caledonian Canal at night in February with an experimental limpet mine strapped to his chest. He fixed it to the underside of a naval vessel and when he got back he rang them, and said, "Consider yourselves sunk". His only other comment was on the temperature of the water!

In 1948, when an Instructor at Sandhurst he selected four likely Cadets to teach them how to pole vault. Clad in a suit, ordinary shoes, cap and pipe he cleared "an unrecorded eleven feet" to show them how simple it was.

After a tour as Chief Engineer Northern Command, during which he initiated the first ESSE (now Military Works Services) Conference, he was appointed Commandant RSME (1962), the first Kingston graduate to be so honoured. His Deputy at the time describes his initial briefing: "I shall leave you entirely alone to run your side of the RSME, but if you want my opinion over anything at any time, this is an ever open door." And so it proved to be—in both directions. In the two years they worked

Brigadier J G Carr CBE BA

together the Commandant never interfered with decisions or action of his Deputy but always backed his judgement where necessary even when his own advice had not been fully followed.

When a delegation of Trades Union Leaders was invited to visit Chatham his forceful explanation of the difficulties of the "Royal Frustrated Engineers," followed by an uproarious Guest Night, swept a lot of problems out of the way. He was also largely responsible for developing the now completely accepted situation that the RSME "belonged" to the Medway Towns.

His pride as a Canadian in being privileged to serve in the Royal Engineers led to his organising the presentation by all its serving and retired Kingston ex-cadets of a distinctive piece of silver to the Corps HQ Mess. Few knew how much thought and effort went into this. Some 150 Officers, by then spread all over the world, were involved and the successful achievement of this during his final days of service meant much to him. He had a way with him and the interests of the Corps were never far from his heart. He sometimes meted out rather forthright treatment to those not giving of their best but outside the office he was a friend to, and respected by, all.

The overwhelming characteristic throughout his life was cheerful courage. He set himself and his subordinates a high standard of behaviour and conduct. His leadership was successful mainly because of his personal example and his enthusiasm for whatever had to be done. As an athlete in his early years it must have been especially galling to suffer such crippling disablement as he faced at the end but he was always cheerful and a real joy to be with. It was ever the same never-to-be forgotten Jim Carr.

In 1941 he married Joyce Ranicar, and many will remember with gratitude their generous and cheerful hospitality. Of their three sons, one is a serving officer in the Corps.

BGB, WGHB, AJHD, KFD, JJDG, FLFM, EEP

* * * *

BRIGADIER C T EDWARDS CBE

Born 27 November 1898, died 8 October 1978, aged 79

CLAUD EDWARDS and I first came together in 1928 in Kirkee where he Commanded a Field Company of the Royal Bombay Sappers and Miners and I was the latest joined Subaltern. We were drawn to each other by a common love of horses—he being well enough off to run a comfortable married establishment and to own three polo ponies of high quality, I scratching along as a bachelor with one mediocre pony bought on tick and a *seven-eighter* hired from the local Indian Cavalry Regiment.

Claud demonstrated his thoughtfulness, generosity and trust by helping and encouraging me in every possible way and then—when the time came for him and his family to go on leave to the United Kingdom—by leaving his ponies in my charge for eight months with no limitations as to their use. I used them to the full and handed them back in due course in good order—thank goodness!

Our next session together was in 1939 when I was a student at the Staff College, Camberley, and Claud was an instructor. He and Maud eased our way on arrival by an immediate invitation to dinner and most helpful advice and then again we shared our horsey activities—he with a couple of blood hunters of his own, I with a hired Government horse but a very good one. I certainly enjoyed my year and I believe that Claud did also despite having rotten luck with his horses, one going wrong and one having to be destroyed after being staked out hunting. Claud showed his quality by never grumbling or being down in the mouth.

Claud and Maud retired to Yorkshire where they developed a lovely garden and a useful little pheasant shoot which I was lucky enough to sample from time to time. Claud loved field sports—particularly the horsey ones—and he and Maud were generosity itself to those who shared this love but were less well able to indulge it. He was a delightful man and a wonderful friend who would support one through thick and thin. I mourn his passing.

Claud was able, experienced and conscientious to a fault. He would have gone further in his chosen Army career had he not been so modest and so reluctant to step into the limelight. The only limelight that he might have craved would have been to be first past the post in a point-to-point or a member of a successful polo side.

I and all who knew him well will miss him greatly.

Peter, his only son, followed Claud into the Corps, saw the World War II through in the Guards Armoured Division and then, shortly after that contest, left the Army to go into Industry, where he has had, and is still having, a most distinguished career.

CPJ

Brigadier C T Edwards CBE.

BRIGADIER H F G GREENWOOD CBE MC

Born 15 November 1894, died 8 July 1978, aged 83

HAROLD FRANCES GUSTAVE GREENWOOD was born on 15 Nov 1894 in Peterborough, Ontario, Canada. His father was Lieut Colonel H S Greenwood (RE) and his mother, Matilda (Tilly), was the daughter of Sir Henri Gustave de Lothbinière, a direct descendant of Montcalm's Chief Engineer at Quebec. His uncles included Major General Alain de Lothbinière (late RE), Brig General Henri de Lothbinière (late RE) and two of his aunts were married to RE Officers, Brig General Nanton and Colonel Mills. His elder brother left RMC Kingston with the Sword of Honour and a commission in the RE.

It was not surprising when, on the outbreak of the Great War, as he was entering his third and last year at the RMC, he immediately volunteered for, and was given a commission in, the Royal Engineers. After a short time at Chatham he joined 5 Field Company (Fd Coy) in the 2nd Divisional Engineers taking part in the battles of Festubert (May 1915), Loos (September 1915), Somme (Summer 1916), Cambrai (Winter 1917), the retreat in the Spring of 1918 and the final advance until the surrender and the march into Germany halting just short of the Rhine and Cologne. Except for a rest period with an Army Troops Coy, he remained with the 2 Div Engineers throughout the War. He bore a charmed life even surviving a 5.9 howitzer shell exploding within two yards of him with nothing worse than a bit of shell-shock and deafness. He claimed he heard that shell from the time it left the gun as he lay flat on his tummy biting the grass.

Early in 1919 he was ordered to Chatham for post-war Supplementary Engineering Course, an excellent way of stabilizing back to peacetime life after four years of active war. On its conclusion, after two month's leave in Canada learning the art of salmon fishing, he was posted to India and put in charge of a draft of the Royal Irish Regiment. The Irish troubles were in full swing at that time and they mutinied. He led a raid of English troops armed with pickhandles on the draft's quarters at 5am dawn, seized the ring-leaders and locked them in the Guard Room. When they recovered their surprise the remainder of the draft roared up the stairs, but were met by a solid line of bayonets. On arrival in India the ring-leaders were court-martialled. The Battalion was subsequently disbanded.

He had been posted to the KGV'sO Bengal Sappers and Miners (S and M) and went to Roorkee to learn Urdu, polo and shooting before taking over command of 5 Fd Coy in Rawalpindi. The Company moved up to Waziristan for work on the Wana-Razmak road towards the end of 1922. Wonderful work was done by the S and M under terribly difficult conditions constantly harassed by Wazir and Mahsud tribesmen. General (later Field-Marshal) Sir William Birdwood visited and "spoke warmly of the high standards of the Fd Coy Commanders Robertson and Greenwood" (3 and 5 Fd Coys). The official history reports that the 5 Coy built a retaining wall at a zigzag bend with boulders so huge that thirty men were required to move them. The finished hairpin was known thereafter as "Greenwood's Corner". For this and other exploits he was made a Brevet Major.

He returned to the Home Establishment as a Coy Commander in the Training Battalion at Chatham and also had a period with Works Services. In 1928 he returned to India for a second five year tour and was on the staff of the Chief

Brigadier H F G Greenwood CBE MC

Engineer (CE), Northern Command, once again engaged in operations on the Frontier.

He returned to the UK in 1933 to command 12 Fd Coy in Aldershot. A then subaltern (AGPL) of his says:– "At Aldershot he lost no chance to experiment with mechanical equipment, which he somehow managed to borrow, and with mechanized mobility on manoeuvres in 1934, centred around an experimental mechanized force, he persuaded the CRE to let him loose on a wide sweep to the edge of the manoeuvre area to set up minefields to the incredulity of the umpires. He swept a bit too far and was confronted by an irate farmer claiming enormous compensation for trespass. Harold was quite unperturbed and used his charm to such good effect that the worthy farmer withdrew all objections and parted the best of friends."

In 1935 he went to India for his third tour as OIC Workshops Royal Bombay S and M at Kirkee. Here he introduced Canadian canoes and sailing races in them. He was moved to the E-in-C's staff in India culminating in Brigadier Engineer Staff. General Sir Clarence (Chirrya) Bird, then E-in-C India says "It fell on him to handle the great task of the expansion of engineer units and services, which he did with conspicuous and invaluable success during my term of office 1939–42. He was indefatigable in dealing with this heavy workload, for which he deserved the highest praise". The figure of 10,000 men in the Indian Engineers was actually increased thirty-fold to 300,000 men. Amongst other things he foresaw on the outbreak of war the future need for Mechanical Excavating Equipment and the tiny drop that would come out of the pipeline from Home Command. So he placed an order in the USA for equipment valued at millions of pounds. It was this equipment that lasted throughout the war. The Mechanical Equipment Companies (Mech Eqpt Coys) were the first to be raised anywhere in the Empire. He also initiated Engineer OCTU's at the three S and M Corps HQ to train officers for this huge expansion and liaised with the State Forces, who had engineer units, to bring them into India for training and use with the Indian Army. He received the CBE in 1942.

In 1942 he went to a Senior Officers War Course. The invasion of Malaya interrupted this and he was sent to Ceylon as CE to organize works for its security. The Garrison had consisted of one Regiment of Infantry, some Coast Artillery troops and a TA unit of Engineers. Ultimately the build-up included two divisions with their ancillary troops, a considerable force of Naval and Air Force personnel and 5000 Ceylonese Engineers, the latter organized into Battalions and Mech Eqpt units with a large workshop and engineer stores organization. This all required accommodation, hospitals and new airfields. On Easter Day 1942 however, carrier

Greenwood's Corner, on Wana-Razmak road, Waziristan

Greenwood's Corner on Wana-Razmak Waziristan

aircraft based on a Japanese fleet operating off the coast of Ceylon raided Colombo, and two days later Trincomalee. This helped to accelerate the work, particularly on airfields, and East and West African Divisions came to the Island to train.

In March 1943 he was appointed CE to the Indian Expeditionary Force, which almost immediately became the 11th Army Group, with South East Asia Command (SEAC) over it and only one Army (14th) under it and GHQ India doing the logistical work. General Hasted and he had been subalterns together in 5 Fd Coy most of World War I, so they formed an excellent team for fifteen months. He was the only Chief Engineer of an Army Group in the War who was not a Major General. The appointment became so as soon as the new Commander relieved General Gifford and brought with him a new staff and the promotion authorization , which had been authorized for several months so I understand. He was informed by his successor that his ship left in two day's time and he returned to the UK to be CE Western Command, his final appointment, retiring from the Active List in 1947, after thirty-three years' service.

He began a new career in the Civil Service as a Regional Engineer. He spent two years with HM Forestry Commission in Scotland, mainly on roads, three years with Scotland and Yorkshire Ministry of Fuel and Power on open-cast coal mining, three years with the Ministry of Works, five years with the Transport Commission (Docks) and six years with the Railway Board London Midland Region, building, amongst many other things the Bletchley Flyover. He finally retired in June 1965 at the age of seventy.

Throughout his career he put his heart and soul into every job he tackled to ensure that it was done to a high standard, and no one had higher standards than he. He knew how to handle men. Although a shy man he was a very straight talker but when he had had his say, that was that, and the next day there would be a grin for the sufferer. A far sighted, imaginative man of great charm he had the knack of stimulating enthusiasm all around him.

At RMC he won the Mile Cup and was a member of the Football and Ice Hockey teams, he played Rugby for the Corps and was in the 1928 British Olympics Ice Hockey Team, he played hockey and polo in India, he was a keen *shikari* scaling the heights in the Himalayas to shoot *markhor, tahr, goral* or alternatively fishing for trout and *mashir*. Truly a very athletic sportsman.

In 1928 he married Gwyneth Lemon from Winnipeg. To her, his daughter and three grandchildren we extend our sympathy. He will be greatly missed by many others and the Corps owes much to him. HRG

* * * *

COLONEL C A K INNES-WILSON CBE FRICS

**Born 20 June 1905, died 12 September 1978, aged 73*

CAMPBELL AUBREY KENNETH INNES-WILSON was at school at Fettes. He went to The Shop in September 1923 to join the last of the two-year terms and was commissioned in February 1926 with an antedate to September 1925. His family had many ties with India and his firm intention was to get to that country at the earliest possible opportunity and into the Survey of India, a service for which his mathematical ability and talent for drawing and calligraphy admirably fitted him. After Chatham and St John's Cambridge he was sent to India; but to Roorkee not Dehra Dun. A posting to the Bengal Sappers and Miners was considered a "plum" for the ambitious Sapper subaltern and when he left to join the Survey of India the moment a vacancy occurred this raised some eyebrows and pursed some lips. But he was undeterred and the Survey thus gained one of its most brilliant officers.

During the ensuing years he served in almost every part of the Indian Empire from the North-West Frontier to Burma and more than once almost met his end from the hazards of its wilder regions. He acquired exceptionally wide experience of survey, on the ground and from the air, as well as of map reproduction, a subject on which he compiled the Departmental Manual. He served for a period at HQ as Assistant Surveyor General, there demonstrating his extraordinary skill and facility in administration. He was equally at home in the wilds and amongst the *babus* and files of Calcutta and Delhi. He relished the pleasures of the city and it was difficult to know whether to admire most his uninhibited enjoyment of these or the incredible speed, accuracy and wisdom with which he would get through his office work—written always in impeccable prose and a beautiful hand—in order to make time for a satisfactory evening's entertainment.

During the war, after a restless period in civil employment, he escaped to serve with distinction in PAIFORCE and Burma, where he eventually became DD Svy after advancing with the victorious 14th Army from India to Rangoon. For his services he was mentioned in despatches twice and made an OBE.

After the war he returned as Deputy Surveyor General to Delhi, at that time in the ferment of Independence and Partition. The reactivation of the Survey of India, and its splitting into two, raised many problems but he was never too busy to concern himself with the plight of the minority Muslim community, many of whom he shepherded to safety, often at great personal risk.

He reverted to the UK and served for a short period in the Ordnance Survey before retiring from the Army in 1949. His restless nature then led him into a varied succession of jobs. He worked for an Air Survey Comapny in India before becoming Surveyor General of Pakistan from 1950–54. This earned him a CBE at the instance of that country's genuinely grateful Government. He became an RO1 at the War Office where he remained until his restlessness took him to another Air Survey Company in South America in 1957. In 1960 he returned and settled down at home as a Planning Inspector, the first of many retired Sapper Officers to be employed thus. His outstanding success here was an excellent advertisement for the Corps and must have greatly benefited those who followed him. He retired finally in 1971.

Intellectually Kenneth Wilson was a brilliant man but his most obvious quality was his irresistible charm, something felt by everybody, young, old, male, female,

Colonel C A K Innes-Wilson CBE FRICS

rich, poor, coloured, white—even by animals. Everything that happened in his company was made amusing. His almost theatrically distinguished good looks caught every eye but he was quite devoid of conceit and abhorred any form of pomposity; indeed he relished the ridiculous situations in which he often managed to land himself. Always unconventional, he had little time for the traditional outdoor amusements of the Army, natural athlete though he was. Riding and shooting left him cold; yet on a visit to relatives in America he somehow found himself, still clad in his travelling plus-fours, addressing, as guest of honour, an immaculately dress-suited company at the Annual Dinner of the New York Polo Association. Again, when his camp in Burma was attacked in the middle of the night by a rogue elephant, he shot it—with his eyes shut as he always swore—to discover afterwards that it broke most of the current game records: it was the only animal he ever shot at.

Not all charming people have goodness but Kenneth certainly possessed it. He was quick tempered and the views he expressed were those of right wing intolerance; but in truth he was a most charitable man and an unswerving champion of the underdog. His real anger was reserved for those who oppressed others. He faced his painful death with great gallantry and preserved his sense of fun to the end. Within a day or two of losing consciousness he was still—to their obvious delight—flirting with his young nurses.

Kenneth Wilson never achieved—because he never sought—the worldly eminence for which his outstanding qualities certainly fitted him; but he enjoyed life and discharged with distinction whatever duties came his way. He won the trust and respect of all around him and delighted his innumerable friends with his humour and wit: for him that was enough.

To his widow Lorna, whose steady support in the ups and downs of their changing world meant so much, and to their son David and his family we send our deepest sympathy.

RCAE

Willie Wilson as he was then known was a most lively and gifted member of my 14 YO Batch. Always on for a party—and the life and soul of any form of celebration—he was always to the fore professionally and of outstanding neatness as a scribe or cartographer. We enjoyed his company at The Shop, during our courses at the RSME and then at Cambridge where he graced John's with Tam Wright.

Sadly, when our courses finished, our ways parted—he to Survey, I to general soldiering—but we were both in India for the early years of our service and I would hear of him from time to time, usually in connection with some jollification whether it be driving a railway engine out of hours or making mock of Authority in the nicest and most amusing way. It wasn't until long after World War II that we met again and I am glad to say that I found the same old Willie—quieter perhaps but still easily recognizable!

Willie was a man we all loved and we benefited greatly from him. He will be sorely missed.

CPJ

* * * *

Book Reviews

GERMAN AIRCRAFT OF WORLD WAR 2

KENNETH MUNSON

(Published by Blandford Press, Price £5.95)

KENNETH MUNSON has some forty books to his credit, including the Blandford Press successful fourteen volume series *Pocket Encyclopaedia of World Aircraft in Colour*, but this must be his best. He has used a new format describing and illustrating more than 100 principal types of aircraft, more than sixty in colour. The technical data is presented in a manner which makes it simple to compare detail without intruding upon the main narrative. In addition the book gives production figures, Luftwaffe Unit codes, Luftwaffe colours, the principal centres of aircraft and aero-engine production, technical data tables of minor aircraft types etc as well as a most useful bibliography and index. The book whets the appetite for those venturing into this very popular field but will also appeal to anyone who is already deeply interested in the subject.

EEP

BOOK NEWS FROM INSTITUTION OF CIVIL ENGINEERS

All books in this section are published by Thomas Telford Ltd and are obtainable from the Marketing Dept, Thomas Telford Ltd, Telford House, PO Box 101, 26–34 Old Street, London EC1P 1JH.

TRAFFIC DATA COLLECTION

Price UK and Eire £7·50; overseas by air £9·00

PROCEEDINGS of a conference sponsored by the Dept of Transport, the Institution of Electrical Engineers and organised by and held at the Institution of Civil Engineers, London, on 5–6 April 1978.

A variety of regular traffic censuses and surveys have been established for a number of years using human enumerators and automatic counters linked to sensers on the road surface. Requirements for an overall system of accuracy are suggested, discussed and answered.

THAMES GROUNDWATER SCHEMES

Price UK and Eire £10·00; overseas by air £13·00

PROCEEDINGS of a conference organised by the Institution of Civil Engineers and held at the University of Reading 12–13 April 1978.

The Thames Groundwater Scheme is the first large scale regional project to augment stream flow by groundwater. Since the initial proposal some thirty years ago there has been a massive development of knowledge. The idea was presented to the public by a PR firm. The story of the success both technically and environmentally is outlined in these papers; for example in 1976, during a period of critical drought, the system gave some 20–25 million gallons a day for about three months, when it was desperately needed.

COMPUTER METHODS IN TUNNEL DESIGN

Price UK and Eire £10·00; overseas by air £13·00

A SELECTION of papers presented at an informal discussion organised by the Institution of Civil Engineers jointly with the British Tunnelling Society and the British Geotechnical Society, held in London 27 April 1977.

Essentially for the specialist engineer these interesting papers cover lined and unlined tunnels, monitoring of tunnel behaviour and performance as well as the use of computers in design, alignment control and storage of site investigation data.

TRANSPORT OF HAZARDOUS MATERIALS

Price UK and Eire £5·50; overseas by air £7·00

PROCEEDINGS of a symposium sponsored by CEI and CSTI, held at Institution of Civil Engineers 15 December 1977.

The volume and variety of hazardous materials being transported increases year by year. Disastrous accidents have been rare but the consequences are grave and public alarm is understandable. The multi-discipline symposium dealt with both existing safety measures and possible improvements. The short section on Risk Assessment is particularly interesting.

MANAGEMENT OF LARGE CAPITAL PROJECTS

Price UK and Eire £9·50; overseas by air £12·00

PROCEEDINGS of a conference organised by and held at Institution of Civil Engineers 17–18 May 1978.

The papers were presented by an international "cast" and covered project initiation and finance, management structure and organisation, contractural issues and human resources in addition to the actual execution of works, commissioning and maintenance.

HISTORY OF THE CORPS OF ROYAL ENGINEERS

PRICE LIST 1978

		MEMBERS	NON-MEMBERS
Volume I	Norman times–1860	£4·50	£9·00
Volume II	1860–1885	£4·50	£9·00
Volume III	1885–1914	£3·00	£6·00
Volume IV		£3·50	£7·00
Volume V	1914–1939	£5·50	£11·00
Volume VI		£3·50	£7·00
Volume VII		£3·00	£6·00
Volume VIII	1939–1948	£4·00	£8·00
Volume IX		£5·00	£10·00
COMPLETE SET		£27·00	£54·00

Postage and Packing, Surface Mail UK, 70p per Vol up to £1·60 per set
Postage & Packing, Surface Mail Overseas, £3·00 per Vol up to £7·00 per set

Sets for Members may be purchased:

1. By single payment of £27·00, *plus p & p if applicable.*
2. By Bankers Order of:
   (a) 9 monthly payments of £3·00
   (b) 4 quarterly payments of £6·75
   The set will be despatched on receipt of Bankers Order, *plus cheque to cover p & p if applicable.*

Sets for Non-members by single payment of £54·00, *plus p & p if applicable.*

Back Numbers of Royal Engineers Journal

IS YOUR SET OF JOURNALS COMPLETE?
DO YOU REQUIRE A SECOND COPY OF ANY PARTICULAR ISSUE?

SOME 800 issues of the *Journal* have been published. Of these some 750 back issues are available for sale to Members of the Institution of Royal Engineers.
In broad terms:

a Between 1872 and 1904 the *Journal* was published monthly and combined the functions of both the *Journal* and *Supplement* as we now know them. In appearance it was rather like a foolscap version of the present *Supplement.*

b Between 1905 and 1922 it changed and became very like the *Journal* of today although it was still published monthly.

c Since 1923 the *Journal* has been published quarterly.

The earliest issue available is No XIV published in 1872 (one copy only) and despite its age every word is readable. Some of the covers of early issues are faded and dusty and show their age. The value of these back numbers on the open market would vary from pence to pounds, depending on the content, rarity of issue and the degree of acquisitiveness of the prospective buyer.

As sales are to be confined to Members only, a flat rate of 50p per copy will be made regardless of the open market value.

ARTICLES FOR THE JOURNAL

ARTICLES FOR THE JOURNAL

ARTICLES FOR THE JOURNAL

YOUR *Journal* depends for its existence on articles submitted for publication on historical, professional and technical subjects of interest to Military Engineers.

They may be of any length, but preferably not more than 6,000 words. They should be typed in duplicate on one side of the paper only, double spaced with one-inch margin. A third copy should be retained by the author for checking with proofs.

Photographs to illustrate an article should be black and white prints on glossy paper. Usually not more than four photographs will be published to illustrate each article. More photographs may, however, be submitted from which the Editor will make a selection. The size of the photographs does not matter as they can be reduced in size for publication. Line drawings, maps, etc must be in black ink, and all lines, lettering, etc must be bold and clear to allow for reduction in size when reproduced. Scales must be drawn and not worded.

The copyright of all articles published in the *Journal* is assigned to the Council of the Institution of Royal Engineers.

Payment for articles is at a rate decided by the Publications' and Library Committee. An extra £20 award is made at the discretion of the Committee for articles of particular merit published in each issue of the *Journal*. In addition two prizes, the Montgomerie and Arthur ffolliott Garrett Prizes are awarded each year for outstanding articles by RE officers, not above the rank of Lieut-Colonel, published in the *Journal*.

Articles may be submitted at any time and correspondence is always welcome. However, the following dates are normally the latest for inclusion in the issues shown:

MARCH ISSUE	1 DECEMBER	SEPTEMBER ISSUE	1 JUNE
JUNE ISSUE	1 MARCH	DECEMBER ISSUE	1 SEPTEMBER

For articles requiring clearance attention is drawn to Military Security Instructions Part 1 Army Code No 60723 Appendix B to Chapter 5.